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UNIDO RESEARCH PROGRAMME

Productivity in Developing Countries: Trends and Policies

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
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Foreword

Carlos A. Magariños
Director-General of UNIDO

How you live on this earth depends on where you live. This is why we have to witness the daily agonies of innumerable workers trying to get into countries where productivity is much higher than in their own. It should not be like this. It should be the reverse: I believe that productivity should, instead, be brought to these places that lag so dramatically behind.

How we go about achieving this is obviously central to the agenda of international solidarity. This book is an attempt to provide an answer.

The answer, of course, is technology, but we have now learned to be leery of facile attempts to construct a single explanation for the considerable variations in time and place of this fundamental force. Behind technology there are both proximate and distant determinants. These must be combined, and the combination of these that really matters, as this book tells us, depends on the current level of technology in a given country.

But not all is endogenous to any one country. We are invited in this book to contemplate the spectacular shift of the world technological frontier and to realize that the conditions in each country are deeply influenced by the levels of technology around the world. This is good news for the emerging countries: the shifting frontier helps them to forge ahead. But it is bad news for the countries that are lagging behind, because the very displacement of the world technological frontier drags them downwards.

An international development agency, however, is not there to contemplate but to help. This book proposes a multivariate framework to guide our actions within the development context of the receiving country. This framework is designed to supply decision-makers with some guidelines on desirable policies.

Translating these guidelines into quantified policy instruments is, of course, another matter. If it can be done at all, it will have to be done *in situ*. But even given a specific time and place, we will seldom have both a convincing enough model of the local economy and accurate enough estimates of its parameters to design measures that we can trust will lead to the desirable outcome that the market cannot offer.

This does not mean, though, that we are ploughing the sea. Guidelines go a fair distance further than the sound but modest advice of Hippocrates, "At least try not to harm thy patient". They also go further than simply playing it by ear, which some economists have proposed.

While this book cannot go quite as far as offering specific designs for action, I trust that it will be received as a useful exercise in the craft of social policy action. It discusses alternative ways to improve existing systems and laudably insists on the high level of governance required to combine economic efficiency, social objectives, transparency, and meaningful evaluation of success.

At the end of the day, what matters is how we extract outcomes from the reality of political economy. In this vital respect, all the experience that has been accumulated and all the bits of knowledge that are added are more than welcome.

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Introduction

What is productivity?

Productivity, as everyone knows, is the ability to transform inputs into output. To allow measurement, this ability is often dressed as a ratio of output to inputs. In this fashion productivity seems so transparent that its deeper meaning is easily lost sight of. However, a sense of mystery unfolds when one pauses a moment to wonder how the value of this ratio may be greater than one. Stating that the ratio is greater than one is equivalent to stating that inputs fall short of "explaining" output. A positive growth rate of the ratio means that the increment of output is more "generous" than would be expected from the mere increments of inputs.

That the whole may be more than the components is not impossible, of course, but it is quite intriguing, in particular to those whose business is to make the most out of scarce resources. Some economists have tried to clarify the mystery by way of a more detailed account of the inputs to be considered, in particular by adjusting inputs for quality changes. The underlying idea is that there is no real excess of output over inputs; there is only an inability to measure the exact amount of inputs involved in production. Others see productivity as a mixture of technical change and efficiency change (economies of scale, learning-by-doing, capacity utilization, spillovers).

UNIDO stands with the latter school. Productivity growth is thought to be a fundamental source of growth and the mystery of productivity one of the most important questions to explore today. In the most general technical terms, productivity can be defined as the ratio of some index of output(s) over some index of input(s) used in production. This definition gives rise to the crudest form of productivity measure, namely, that of average single-factor productivity, which is arrived at by dividing the volume or value of output by the volume or value of a single type of factor services. The most frequently cited version of average single-factor productivity is that of average labour productivity in the form of output per worker.

While the output/labour ratio is easy to compute, it suffers from a serious shortcoming as a measure of productivity of the single factor labour. A more sophisticated method consists in considering the productivity of the principals or of all (identified) factors combined; this is the total-factor productivity method (TFP). In this book, a step is made in the direction of TFP productivity to the extent that not one but two factors will be taken into account: labour and capital.

Why this productivity study?

Any international organization dealing with economic development is concerned with the question of how to generate per capita growth. This is not because growth is synonymous with economic development. The effects growth has on indices that could be taken as indices of

welfare are diverse. It is not always the case that the richer country has the longer life expectancy, the higher education, the less polluted atmosphere, and so forth.

Nor is it because development is absolutely impossible without growth. Surely, a modicum of development could be implemented without any growth, by the mere re-arrangement of available resources. Rather, it is because neither sizable nor long-term development could even be dreamt of if it did not have the backdrop of per capita growth.

In the ongoing debate on what causes growth, at least one point is made: that growth comes from the conjunction of, on the one hand, the accumulation of endowments, and, on the other, productivity gains. Accumulation fuels growth by putting more inputs at work in the economy. Productivity gains enhance the ability of the economic agents to transform these inputs into output. Without productivity gains, growth would be submitted to the physical limitations imposed by demography and the supply of natural resources and to the limitation that the savings rate places on the growth of capital equipment. With productivity, these constraints are no longer binding. Looking at a cross-country variation of income per worker, empirical studies find that more than 60% of the differences in level and 90% of the differences in growth rate can be explained by differences in productivity (the rest being attributable to differences in physical and human capital).[1]

In OECD countries, productivity gains contribute to about half of growth. In developing countries, too, productivity is an important component of growth. Admittedly, in the first stage of development, productivity is not nearly as important as accumulation. Yet, it is far from negligible. Lucas offers an ingenious rule-of-thumb to concretize what growth can do for development: an economy (country) that grows at the rate g sees its income per capita double after 70/g years. Doubling income per capita is not development but it means a lot of resources for development. A growth rate of one per cent would make that contribution available in 70 years; with four per cent, little less than 18 years is needed. Productivity being one of the sources of growth, it is clear that productivity enhancement translates ipso facto into a higher g. This is why anyone interested in development would value any contribution, however modest, that productivity could make to g.

Moreover, part of the growth that apparently comes from accumulation should actually be ascribed to productivity (high productivity will probably determine an increase of output, hence of savings and capital formation).

Anyway, in the long run, accumulation meets the limits set by its very success. The supply of labour loses elasticity, and the law of diminishing returns to capital sets in. It is then the turn of productivity to take the driver's seat.
An indicator of how productivity actually drives the economy is the extent to which productivity explains the variations of economic growth among countries. In this respect, Beyer

[1] See Helpman, E., The Mystery of Economic Growth, The Belknap Press of Harvard University Press, 2004, p.33.

and Vergara have calculated that 2/3 of the variance in growth rates observed among 107 countries between 1980 and 2000 is due to variations in the rate of TFP growth. In other words, "it is the rate of TFP growth that defines if there will be a bad or a good period of economic growth".[2]

Productivity, in sum, is a facet of growth. At the end of the day, to study productivity is much the same as to study growth. This book, however, is explicitly about productivity. That might seem odd: if it is growth that matters, why not a growth study rather than one on productivity? Why, indeed, go for one of the parts rather than for the total? Here are the reasons why UNIDO has chosen to focus on productivity.

First, productivity is key to raising living standards

UNIDO's corporate goal is to contribute to social advancement. Without productivity there would be no social advancement. In an economy that expanded only in the same proportion as the inputs absorbed in production, the size of the economy would grow but welfare would not. To the economic agent, the marginal utility of extra output would be equal to the amount of capital and labour needed to produce the extra output multiplied respectively by the real rental rate of capital and by the real wage rate. From a welfare point of view, the economy would tend to a situation such that the utility of the increment of income would be offset by the disutility of the increment of efforts. In other words, without productivity gains, one hand would give away all the welfare that the other receives.

Without productivity gains there cannot be welfare gains. Yet, it must be admitted that productivity gains are only the wherewithal to welfare improvement. Economic mechanisms may offer a productivity outcome and propose a distribution between consumers (by way of price reductions) and factors connected to production (by way of remuneration of their services). But how this distribution will actually occur, and how effectively it will be directed to welfare improvement, is another story. Here, it is the interplay of socio-political processes that will have the last word.

Second, productivity is key to poverty reduction

Research is accumulating evidence that the fundamental solution to poverty is productivity. A recent report from the Centre for the Study of Living Standards (CSLS), prepared for ILO, provides evidence of the impact of productivity growth on poverty reduction in developing countries.[3] According to this report, labour productivity growth accounts better for changes in poverty than economic growth. Productivity does better against poverty than overall growth

[2] Beyer, H., Vergara, R., "Productivity and Economic Growth: The Case of Chile", Central Bank of Chile, Working Papers, No174, August 2002, p.24.
[3] Centre for the Study of Living Standards, "Productivity Growth and Poverty Reduction in Developing Countries", Background Paper to the 2004 World Employment Report, 2003.

because productivity specifically generates skilled jobs, which are sources of income and social participation.

Recently, also, a research team estimated the effects of a 10% increase in Argentinean productivity. Using a computable general equilibrium model associated with micro simulations based on household surveys, they found that employment increases by more than 14% in almost all sectors, that the nominal remunerations increase slightly and that the price of the basic basket of commodities decreases. "These three effects together led to a dramatic drop in poverty (21%), in particular, extreme poverty (30%), and to a strong decrease in inequality."[4]

What these examples show is that the impact of productivity on poverty passes through employment. To be fair, it should be acknowledged that a positive elasticity of employment to productivity is conditional upon the net effect of productivity on GDP growth. Productivity always stimulates growth, but this occurs through a process of destructive creation.

Employment wins when job creation is stronger than job destruction. A rule-of-thumb is that to generate a net flow of jobs, output must exceed productivity growth by 1 to 1.5 percentage points. How do we interpret the many cases of rapid productivity growth combined with falling employment? Is job eviction due to excess productivity or to insufficient growth? The answer provided by careful analysis is that the real reason for job losses is deficient growth. It is when rapid productivity growth occurs in sectors already trended towards declining employment that the net impact materializes as a fall in the number of jobs. Whether a sector is trended to declining labour utilization is due not to productivity increases but to factors such as inefficient labour markets that impair the reallocation of labour, or technological change biased against labour, or price-elasticity of demand, or prices of competing goods and services, that play against the expansion of the sector.

Third, productivity is key to a sound environment

As the size of an economy grows, the environment is affected. Other things being equal, the pollution of the environment may be expected to increase in proportion to the increase in GDP. But if productivity gains are made, less input is needed per unit of output and this would bring down the pollution/output ratio.

Things, of course, cannot be maintained equal, because productivity gains come, basically, from technological change, in other words, from new ways of producing goods and services. What happens when a new technology is introduced? The possibilities are wide open. The new technology may be cleaner or dirtier. Its impact on welfare is normally measured by its contribution to GDP; its impact on the environment is usually not assessed.

[4] Diaz-Bonilla, C., Diaz-Bonilla, E., Pineiro V., Robinson, S., "Argentina: The Convertibility Plan, Trade Openness, Poverty and Inequality", Food Policy Research (IFPRI), Washington D.C., p.21.

It is likely that the largest increments of pollutants are being added by the rapidly developing economies. This is because the potential welfare gains are so huge that nothing would seem worthy of impeding their realization. But it need not be like that. Countries at the beginning of rapid trajectories are also those that offer opportunities for adopting state-of-the-art technologies that will avoid the pollution costs of the future.

UNIDO is deeply concerned with the impact of technologies on the environment. Actually, some 2/3 of UNIDO's technical assistance is geared toward this concern. This concern is one of the reasons that led to the present book.

Fourth, productivity is the natural domain of UNIDO's activities

That productivity appears to be important for economic growth, for welfare gains, for poverty reduction, and for the environment should be enough to call the attention of any agency involved in the struggle against scarcity. This is particularly true for UNIDO.

UNIDO's mandate has two dimensions. One indicates the function to be performed; the other indicates the scope of action. As far as the functional dimension is concerned, it is clear that UNIDO's business is not to provide factors on the accumulation side of growth. UNIDO is there to help countries make the best possible use of resources under their command, in other words, to help in productivity matters. When it comes to the scope, it so happens that UNIDO's is precisely a domain where productivity arises. Productivity growth occurs principally in sectors producing goods, like agriculture, manufacturing and mining. In services, too, productivity increases: Malls replace small proximity shops, computers replace clerical and technical work, handheld GSM replace telephone standard operators and so forth. But, by and large, it is in the sector that produces goods by means of goods that the productivity intensity of growth is at its peak.

As the international organization promoting industry in the service of development, it is clear that UNIDO is in a good position to observe productivity and to retro-feed this view in its programmatic focus, its policy-advice services and its technical assistance activities.

What is the research strategy of this study?

The objective pursued is to understand how productivity occurs and works, why this happens, and how the productivity phenomenon can be influenced by policies. To get as close as we can to this objective, we have adopted the following strategy, and as a starting point for further investigation, the following framework of assumptions is made:

- The level of productivity – the output return on inputs – is defined by the state of our knowledge of production techniques. Productivity changes chiefly because, throughout time, the world set of available techniques (in short, world technology) is continuously

changing in the direction of more productive techniques. More efficient techniques enter the set; less efficient techniques are discarded

- Access to this set is not, however, the same for every country. Very simply, technology is what works. In practice, a country can only access that part of the technological set that will work in its particular home conditions. To simplify, let us say that the top technological levels are accessible only to developed countries; the intermediate levels are accessible to developed and emerging countries; and the lower levels are accessible to emerging and other developing countries (advanced countries cannot operate low-productivity techniques because labour costs are too high).

- World technology does not change in a homogeneous fashion: the top levels shift faster than the bottom ones. Consequently, countries on the bottom technological strata are doomed to become ever more distanced from the rest of the world as long as their domestic conditions will not permit them to climb the technological ladder

- The position of a country on the ladder of technology potential is geared by the current level of productivity of that country, which itself is defined by past levels of accumulation and innovation.

- Given its position on the ladder, the technology potential of a country is defined by two proximate determinants: the apparatus of technology creation and diffusion (i.e., R&D), on the one hand, and the skills of the labour force manning this apparatus on the other. The long-term development of the two proximate determinants is necessary, but not sufficient, for a country to climb the ladder of technological capability. Actually, the word "determinant" is used here only because it belongs to the jargon of econometrics. Instead of "determinant" one ought, perhaps, to talk of "sails". R&D and human capital are like the sails of the productivity ship. When the wind of opportunity blows, the sails propel the ship. Without wind a ship under sails does not move; actually, deploying the sails might even hamper using the currents of capital and labour accumulation to manoeuvre the ship.

- Within its endowment potential, any country can perform more or less well. Some will make full use of their potential; others – most countries – will only make partial use. A host of factors are at play in explaining the actual utilization of a country's productivity potential. Pursuing the previous metaphor, these factors would be the rigging with which the sails are optimally set to capture the wind.

Chapter 1 begins by recognizing, on the basis of the interplay of theoretical and empirical arguments, that the deep cause of productivity is technology and that its proximate determinants – the sails – are R&D and human capital. The more distant determinants, then, constitute the rigging. The starting point is a list of potentially relevant determinants of productivity delivered by a review of the pertinent literature published since 1990. The statistical regularities analyzed in the literature are obtained at the aggregated level of cross-section analysis. In order to

understand why and how the regularities obtain, Chapter 1 looks at these determinants at country level. The assumption is that the country level widens the field of experience by bringing in a wealth of details and particular circumstances without which it is impossible to contextualize how the determinants transmit their influence on productivity. The country evidence is provided in an analytic narrative covering 15 individual countries studied by national experts. The chapter ends with a section of conclusions that draw the lessons from a confrontation between the relationship predicted by statistics and the relationship observed at individual level, after showing the convergences and divergences between predictions and reality.

Chapter 2 explores the above hypotheses empirically. A world technological frontier is econometrically drawn from a database specially constructed by UNIDO. Observations collected over 40 years in 112 countries are used to integrate all the countries in a single frame of reference. Data on levels of productivity provide an indication of a country's position in that frame. The relative position of all countries gives the pattern of manifestation of the phenomenon of productivity. The position of countries in relation to this frontier is defined by their technology potential (the sails) and by their efficiency in using this potential (the rigging). The frontier shifts through time (when the wind of opportunity blows) but not in a homogeneous fashion. The bottom part is rigid whereas the top part is supple. With time, the supple portion shifts, opening up opportunities and creating challenges. It follows that the positions of the countries with respect to the frontier also change. Chapter 2 presents a certain number of stylized facts captured by observing the data through this prism between 1960 and 2000. An extremely synthetic summary of these facts would be that on the map of productivity the countries are agglomerated in three groups, apart from each other and yet interrelated.

Chapter 3 deals with policies. UNIDO and other international organizations do not look at productivity just out of intellectual curiosity, but for the sake of exerting or catalyzing pro-productivity actions. The first two chapters have identified a wide range of productivity drivers. Some of the factors identified are affected by policies; others are well beyond the influence of policy. This chapter examines how policies affect drivers from the first category; more precisely, it assesses the range of pro-productivity actions that may be considered, what shape these actions should take, how they are interrelated, and in which circumstances they are effective. The chapter particularly proposes policies deemed to promote the development – especially the qualitative development – of the proximate determinants (the sails).

Chapter 4 continues with the topic of policy but this time focussing on policies oriented towards the factors that define whether and to what extent the potential productivity performance of a country is actually utilized (the rigging). These are a host of factors, designated under the generic name "business environment". This chapter shows that technology is translated into productivity gains to the extent that the business environment is favourable and discusses medium and long-term actions that could be taken on this environment to benefit productivity. The conclusions describe the attributes of a policy framework that would ensure a multivariate process combining continuity and flexibility and propose the scope of action that UNIDO could take.

Chapter 1: The deep source of productivity and its determinants

Introduction

This chapter shows the interplay between the theory and evidence that led to the consideration of technology as the deep cause of productivity. Two proximate determinants gear the technological potential of a country: the apparatus of technology creation and diffusion (R&D), on the one hand, and the qualified personnel manning this apparatus, on the other. A host of other factors, subsumed under the term "business environment," define the degree to which this potential is actually utilized.

1.1. It must be technology

1.1.1. Facts and theory indicate this

Basically, productivity gains come from the efforts of people to improve their condition amidst scarcity. These efforts take place in multifarious ways. For instance, Harberger recalls the owner of a clothing plant in Central America telling him "of a 20-percent reduction in real costs, following upon his installation of background music that played as the seamstresses worked."[5] It is interesting that sometimes the mere playing of background music makes productivity tick; however, the main source of productivity must lie elsewhere. According to most economists, the truly important source of productivity is the application of knowledge – principally scientific knowledge – to the production of goods and services. In short, knowledge about techniques (or, in Romer's famous binomial expression, "ideas" about how to do "things") is called technology. The view that technology is the main factor of productivity is held on both theoretical and empirical grounds. Looking at the historical records, one cannot miss the reality of growth. Admittedly, during the first millennia of mankind it was growth paced by demography. But, since the Industrial Revolution 250 years ago, it has become growth per capita. The acceleration of growth between the two periods is spectacular, and theory tells us that it cannot be explained simply in terms of capital and labour accumulation. In an imaginary economy comprised of only basic labour and capital, long-term growth is not possible if capital accumulates under decreasing returns (successive additions of a given unit of capital result in increasingly smaller increments of output). The reason is simple and inescapable: Since the increments of output get smaller and smaller, inevitably there will be an increment of output that will be too small to replace the capital depreciated in producing that increment. As a matter of fact, if one tries to account for growth in any period since the start of the Industrial Revolution only in terms of capital and labour, one is invariably confronted with a huge unexplained residual.

[5]See Harberger, A., "A Vision of the Growth Process", The American Economic Review, vol. 88, No 1, March 1998, p.5.

Two facts then need to be explained: Growth can be sustained in the long term, and growth can exceed the rate of accumulation of material inputs. One way of accounting for long-term growth is to assume constant instead of decreasing capital returns. If successive additions of capital always contribute the same increment of output, growth can go along unhindered forever.

This theoretical arrangement is faced, however, with two problems. First, there is robust evidence that, in the real world, returns to capital tend to decrease. Second, the acceleration of growth since the Industrial Revolution remains unexplained. These evidences cannot be eluded; it follows that the imaginary economy above lacks some important feature.

Following Solow, most economists have reached the conclusion that the missing feature is technological progress. With the progress of technology (new techniques enter the scene, obsolete ones fade away), the transformation of the tangible factors – labour and capital – into output shifts in the direction of more productivity. Thus, notwithstanding the decreasing returns of capital, it becomes conceivable that long-term growth occurs.

1.1.2. How does technology enter into the growth process?

Where does technology come from? Of course, it cannot be thought to come from an inexhaustible cornucopia attending us from outside the realm of scarcity. Instead, growth theory, in its recent developments, has given a central position to endogenous sources of technology. "Endogenous" means that growth of technology – and of the corresponding productivity – is determined by conditions or factors internal to the economy in which growth is taking place.

Now, if technology is treated as endogenous to the economy, there must be an explicit mechanism in the model to elicit technology. When it comes to tangible factors, mechanisms of that sort are well described. Investment and labour services are remunerated because both factors generate income. Where does the remuneration of technology come from? It cannot come from the activity of the tangible factors, not, at least, if these factors are employed in a competitive market structure. If there is competition, factors are paid according to their marginal productivity, which means that, after paying the services of capital and labour, there is nothing left from output to remunerate the contribution of technology. Nothing is, of course, not good enough. Without incentives the mobilization of technology on a scale capable of largely increasing the world growth rate over a couple of centuries is simply not conceivable. How then is technology mobilized? Various solutions have been proposed. What they have in common is treating technology as a public good – a good, in other words, that eludes the market.
One solution consists of picturing a perfectly competitive market where firms care only for using capital and labour but inadvertently generate technology.[6] One way technology is

[6] "Inadvertent" because it is transmitted as an externality. An externality is a real gain or loss exerted by the activity of an agent A over the activity of an agent B without the intervention of market transactions. Since the effect is not transmitted through the market, it is called an externality.

inadvertently generated is simply through the accumulation of physical capital. Take the example of a firm making an investment in R&D; whilst this investment directly increases the productivity of the investing firm, it often happens that it also enhances the level of knowledge of other firms, mostly industrial firms, involved in the same kind of activities. The effect exerted on the investing firm is channelled to the receiving firm through various conduits. Some are market conduits; others are external conduits (externalities).

Probably, the major transmission channel is market acquisition of intermediate products and capital equipment embodying R&D made by an innovator firm and enhancing the productivity of the acquiring firm. Clearly, the market (in this case, the transaction between buyer and seller) does reckon the initial productivity gain; no externality is involved. However, the marketed productivity gain, and the output expansion it authorizes, will provoke ripples in the form of non-marketed additional productivity gains. Thanks to the initial gain, the marginal productivity of installed capital will be enhanced. Facing a higher marginal productivity of capital, both firms are likely to go for further output expansion. This secondary effect was not recognized in the initial transaction. The gain is real, but not recognized by the market.

A model by Lucas offers a different perspective on the same facet. It is also an investment-based model, but here the investment that matters most is investment in human capital. The productivity of an economy can be characterized by the cumulative investments it has made in human capital. The integral of past investments determines the average level of human capital in an economy, and this average level, in turn, determines the productivity of individual human capital.[7] The higher the average level of human capital, the larger will be the amount of output generated by the stocks of physical and human capital endowing the economy.

Treating technology as a public good offers the theoretical plus of authorizing long-term endogenous growth in the context of competitive markets (a context theory likes to see around because of its axiomatic properties). But it clashes with the evidence. In real life, technology is very often far from being a free good, even though portions of it are indeed disseminated freely. Everybody knows that generating laser technology in OECD countries or introducing fertilizers in traditional African agriculture are both extremely expensive endeavours (relative to the host environment). Yet, there is no denying that a portion of technology enters into the productive system through non-market conduits.

Acknowledging this evidence leads to the second solution to the question of technology incentive – a solution that encompasses both free and costly dissemination of technology. Several models are now available to depict a world where firms obtain technology both via explicit expenses and via tapping extra-market sources. One model pictures R&D-based firms that deliberately seek technology through expenditures on R&D. Here, the context of perfect competition has to be discarded to allow firms to finance the fixed cost of R&D by selling at prices exceeding marginal costs. It is replaced by a structure of imperfect competition enabled

[7] See Lucas, R., "On the Mechanics of Economic Development", Journal of Monetary Economics, vol.22, July1988, pp 3-42.

by the technological effort itself. The goods resulting from technological change can be differentiated from other goods, either because they are better (vertical differentiation), or because they introduce a new version preferred by a portion of the consumers (horizontal differentiation). Vertical differentiation is a particularly interesting model in seeking to understand why economies are pushed to climb the technological ladder. A new way of doing things – for example, laser surgery instead of knife surgery, evicts the rivals of the innovator for a while. If that while is long enough, that is, if the new good is superior enough that rivals do not come up too quickly with an even better or newer version, the profit margin will permit the recovery of the costs sunk in R&D.

In the first solution – the inadvertent generation of technology – technological change occurs only because technology is a public good. In the second, it occurs because firms cultivate technology to maximize profit. But because technology is a public good, externalities can also occur in the second approach. As initially shown by Romer, when a firm creates a new design, this design takes two destinations (because they are non-rival, designs are ubiquitous). First, it is incorporated in the good manufactured by the firm. Second, the new design joins the pool of designs existing in the economy. Part of this pool is appropriated by the firm that issued the design, but part also falls in the public domain (a patent divulges, ipso facto, the design it protects). Consequently, the stock of freely available knowledge is enhanced. This freely available knowledge can be used only by firms employing human capital working in R&D. Hence, individual firms that have invested in R&D see the returns on their investment enhanced as the cumulative R&D investment of all firms grows.

1.1.3. What is the impact of technology on productivity?

Both solutions have externalities that enhance the efforts of agents, whether this is the efforts of firms to expand technology or accumulate physical capital, or the efforts of workers to accumulate human capital. These very efforts stimulate growth; in return, thanks to the externalities, growth delivers a positive feedback. This feedback effect is how productivity sneaks into the economy to produce results in excess of marketed output.

There is a version of the feedback effect that is sensitive to scale effects. Of course, this version projects a fairly sanguine light on growth. As the economy grows, the growth rate of the economy is stimulated. In this kind of dynamics, growing economies are attracted towards exponential growth.

Regrettably, the available evidence runs counter to this sanguine view. Observed long-term growth rates do not differ that much across economies that, *a priori,* have very different exposures to technological externalities. The United States, Bangladesh and Equatorial Guinea, for instance, had the same growth rate of output over the 1962-2000 period. Jones and others note that in the United States per capita GDP grew at the average rate of 1.8% over the 1870-

1994 period[8] with no observable difference between the pre-WWII and the post-WWII portions of that trend. Yet, the quantity of scientists, engineers and technicians, as well as the integral of R&D expenditures, is considerably larger after WWII than before.

This evidence casts a doubt on the size or scale responsiveness of R&D-based or investment-based growth models that incorporate non-rivalry or externalities. But what exactly is the nature of this doubt? Is it a doubt about the scale responsiveness, or is it a doubt about the reality of externalities? On the one hand, evidence of externalities continues to pile up in empirical studies (admittedly, sceptics argue that the observations could be an artefact of the econometrics used). Accordingly, it is reasonable to consider that externalities are out there. On the other hand, there is evidence in the historical record that there is no acceleration of growth as the size of the economy grows. Apparently, something goes wrong in the realm of endogenous growth. Fortunately, this something seems to arise merely as an artefact of modelling. Early models of endogenous growth used to impose the assumption of constant returns to scale on factor accumulation. These models had introduced the restriction of constant returns on the underlying production functions, not because reality featured them but because constant returns were a convenient convention to study how the equilibrium of on-going growth was generated. Without constant returns there could actually be feedback without scale effects. Indeed, today growth theory proposes alternative models that tally with empirical evidence of stable or mildly increasing long-term growth rates and still include non-rivalry and externalities as mechanisms of endogenous growth.[9]

1.2. The technology potential of a country

Productivity is determined by technology. In principle, world technology should be common to the entire world. In practice it is not so. When it comes to accessing the technological universe, the countries of the world are stratified. The upper strata of technology are only accessible to developing and emerging countries; the intermediate strata are accessible to almost all countries; the lower strata are reserved for emerging and other countries. In other words, what defines the possible access of a country to the technological universe is nothing less than the current level of productivity of that country. The current level of productivity measures the means that the country can deploy to access the technological set. It is the size of the ship that determines the area of sails that can be deployed. Given the level of current productivity, the technology potential of a country will be greater or smaller according to the two proximate technology determinants: R&D and human capital.

[8] See Jones, C., "Time Series Tests of Endogenous Growth Models", Quarterly Journal of Economics, Vol. 110, No 2, 1995, pp. 495-525 and "Growth: With or Without Scale Effects?", American Economic Review, vol. 89, No 2, 1999, pp. 139-144.

[9] See Jones, C., "R&D based Models of Economic Growth", Journal of Political Economy, vol. 103, 1995, pp. 759-784.

The link between deep and proximate determinants is intuitive. Technology is knowledge applied to production. R&D is the process whereby knowledge is transformed into production. Human capital is human beings with the knowledge to operate the R&D process. These three entities are the three facets of knowledge. Moreover, this intuition is confirmed by empirical research. On the trail of endogenous growth theory, a flurry of empirically oriented papers have made explicit the role of a gamut of parameters on several aspects of growth. It cannot be said that a consensus has been reached. However, going by the literature,[10] it seems fair to say that there is a majority who hold that R&D and human capital best explain differences in the level and growth rate of TFP across countries.

As will be seen later, a given potential may be exploited more or less to the full depending on a certain number of more distant determinants. Before that, however, let us focus on the two proximate determinants.

1.2.1. Access to technology through R&D

Every country, no matter its level of development, is engaged in catching up with some technologies developed by some other countries. The task, though, is much more arduous for developing countries. The latecomer faces two hurdles. The first is technological. Access to the frontier is denied to those countries where human capital or the R&D infrastructure is not sufficiently developed. The second is the market power of the incumbents. The top scale portion of the frontier belongs to incumbents who can charge monopolistic rents for access to the state-of-the-art technology. Given these two hurdles, it would seem that the cost of innovating gets heavier as technology unfolds. If this were true, it could be stated that emerging from backwardness becomes ever more difficult.

The difficult process of catching up can be pursued through the international acquisition and domestic generation of technology. Achieving a right mix between these two is possibly the major policy question facing developing countries in matters of technology. These options will be discussed in the next section.

1.2.1.1. How the upper portion of the frontier shifts

We can assume that the "typical" developing country will have to obtain most of its technology from the rest of the world, in particular from OECD countries. It is interesting to examine this source of technology with a view to understanding how accessible it is by developing countries.

The chain of science - technology - innovation

[10] See Isaksson, A., "Determinants of Total Factor Productivity: An Assessment of Recent Evidence", UNIDO Working Paper, Vienna, 2005.

The machinery that generates innovative technology has three wheels[11]. The first one is basic research, i.e., research conducted in the basic natural sciences – chemistry, physics and biology. The second one is R&D. R&D is knowledge applied to problems involved in the creation of new processes and products (applied research) as well as knowledge applied to problems involved in the development of an existing process or product (development). In the second wheel, scientists, engineers and technicians (SET) work at turning the returns from basic research into inventions that can be incorporated into the production cycle.[12] The third wheel is comprised of innovating firms that convert these inventions into innovations through a process of production and commercialization.[13]

Basic research and R&D represent 2.2% of the combined GDP of OECD countries (in the USA, by far the largest R&D practitioner, the fraction of GDP spent on R&D has fluctuated between 2 and 3% since 1957; in Europe it has fluctuated around 2%). This represents more than US$500 billion per year. It is also 8% of all investment whereas investment in physical productive capabilities is 28%. It engages three million people. The third wheel, too, is sizable. The sectors recognized by the OECD to be intensive users of technology represent 50% of the combined GDP of the OECD.

Basic research gets one-fifth of the total resources spent on R&D, but it engages two-thirds of the labour force involved in technology. In basic research the labour force is very qualified, but distant from the market, hence it is less remunerated. In sum, most of the resources are spent on jobs in the R&D area. The financing of basic research comes mostly from the public sector; less than 10% comes from business. With R&D, three-quarters of the financing comes from business and of this three-quarters, 85% comes from the manufacturing business. Manufacturing is the lever of R&D.

After R&D comes the innovation wheel. Innovation means taking the risk of investing in equipment, machinery, training and marketing in order to turn knowledge (invention) into profit (innovation). The outlay in innovation is more than US$1,000 billion, two-thirds of which is spent in the manufacturing sector.

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[11] This discussion draws heavily on Robyn, G, "Agglomeration and Industrial Development. Lessons from the New Economic Geography", in UNIDO, Industry for Growth into the New Millennium, Vienna, 2000, pp. 51-60.

[12] In practice it is quite frequent that the R&D wheel contributes to the advance of basic research either deliberately – a good handful of scientists have won a Nobel Prize in private laboratories-, or by serendipity – like when Penzias and Watson working on satellite communication discovered the background radiation of the Big Bang (this example is given in Howitt, P., 'The Economics of Science and the Future of Universities', The 16th Timlin Lecture, delivered February 16, 2000 at the University of Saskatchewan, Saskatoon).

[13] Basic research is not the only source of inspiration of R&D. Small firms, too, play an inventive role. Thanks to their flexibility, small firms make unconventional discoveries. Precisely because unconventional, these discoveries face a lot of hurdles on their way to innovation. It is, therefore, not uncommon for small firms to sell breakthrough-ideas to large firms. The latter would throw in a lot of development cost to bring the idea to fruition and bring the product on the market.

In sum, the first wheel generates knowledge that becomes technology in the R&D wheel and which is diffused by the third wheel in the form of new products or new processes. Technology springs from complex machinery organized in a system. We should never lost sight of this notion when we are thinking strategically about fostering technology.

Concentration of R&D

The distribution of privately funded R&D expenditures across manufacturing branches shows a high degree of concentration. Taking together firms from larger to smaller until one has 30% of the value added of the whole sector, one finds that these firms account for more than 70% of the total sector expenditures on R&D. Adding more firms, up to 50% of value added, would account for more than 90% of R&D expenditures. In other words, a few branches, namely, the pharmaceutical, computer equipment and transportation industries, are responsible for the lion's share of such expenditures while less than 10% is spread over all the other branches. Furthermore, only 4% of the outlays come from firms with less than 25 employees.

Why is there such a concentration? Among the gamut of conceivable forces, three have been distinguished by empirical research: technological opportunity, excludability and capital constraints.[14]

Technological opportunity is the stock of inventions that can be accessed with a given level of expenditure. The technological opportunity of manufacturing industries typically finds its origin in fundamental knowledge accumulated in basic research. By the time academic research percolates into industrial innovation, 10 to 30 years would have elapsed. The outcome of a unit of R&D expenditure is difficult to predict over such a long time. To actually benefit from the expenditures initially made on basic research, the investor must be diversified enough, hence large enough, to absorb a cluster of various innovations arriving in one batch.

Excludability is the degree to which an innovator extracts the marginal social product derived from his innovation. Excludability is almost never watertight; leaks to the consumer or to non-innovating firms are the rule rather than the exception. Excludability decreases with the ease of technological imitation and the intensity of competition on the product market. Leaks can be avoided with the help of complementary assets, such as brand-name investments, distribution systems, and intellectual property enforcement. These complementary assets are more easily affordable through concentration.

In the world of innovation it is difficult to write contracts between investors and inventors. By its very nature, R&D fosters information asymmetries and related contract incompleteness between the financier and the research firm. The hazards associated with contract incompleteness include inefficient effort provision by the innovator as the result of imperfect

[14] See Cohen, W. and Levin, R., "Empirical Studies of Innovation and Market Structure" in Handbook of Industrial Organization, vol. II, Elsevier Science Publishers, pp. 1059-1107.

monitoring by the investor; inefficient selection of projects by the investor as the result of imperfect information on project quality; and potential ex-post expropriation of the rents from innovation by the investor as the result of imperfect property rights over the findings on the part of the inventor. Here again, concentration helps to hedge against such risks.

The strength of these three factors varies across industrial branches; therefore, the distribution of R&D expenditures across branches will be skewed. Nowadays, R&D is concentrated in sectors using information technologies, sectors in semi-conductors, and sectors using biotechnologies. Clearly the wind does not blow in all directions, and only those to windward will be able to set sail in the direction of technological progress. A strategy to capture international technology ought, therefore, to take into consideration the tendency of innovative technology to concentrate in a few branches of activity.

The encounter between technology and the economy

Technology has two ways of flowing into the world economies. The first one is incremental. It features expanding the variety and raising the quality of products. Consumers have a preference for diversity in the execution of a core product (a basic tool kit contains at least six screwdrivers). Accordingly, firms seek profit through the diffusion of ever more varieties of what already exists (an Airbus versus a Boeing; liquid crystal versus plasma TV).

Nor is it only more of the same that customers want; they also prefer better quality products. Once on the market, a product shows its virtues and its vices, and consumers are ready to pay a little more to have more of the former and less of the latter. Hence, there is room for a firm to try to beat its rivals by bringing in a better quality product (hybrid versus simple petrol engine).

Expanding variety and rising quality are two drivers of incremental change of technology that are fuelled by R&D. The drivers make the economy grow through product multiplication. In turn, for more and more products to enter the market, R&D must be kept growing.

The second way that technology flows into the world economies is through radical technological breakthrough. Discoveries like the DNA code or the microprocessor generate a radically new technological panorama.

The impact takes the form of a process of destructive creation. The changes introduced are so deep and pervasive that almost all aspects of production are touched (intermediate and final products, work organization, skills, and so forth). Precisely for these reasons, adjustment to radical changes takes a long time and absorbs many resources. The shape of the process is that aggregate productivity falters for a long time before rising with a vengeance. An example of this kind of evolution could be how the costly entrance of the electronic era brought about the world productivity drop from the early 70s to the mid-90s (albeit the drop is sometimes ascribed to the aftermath of the oil crisis or to the rise of the tertiary sector). Over two decades the link between

investment in computers and productivity remained invisible in the USA, the heartland of the new technologies, and, to date, remains invisible in other OECD countries.

In sum, in developed countries R&D and TFP are tightly linked, but the causality is not immediate: there is a long intermediation between the two. R&D becomes productivity only when it enters into the production process or becomes a new product, and this can take several decades.

Conclusion

This formidable R&D machinery in place in the OECD is 50 times bigger than its counterpart in developing countries. In other words, most of the R&D effort is made with investments, labour, and firms located on the top portion of the world technological frontier.

Thanks to this machinery, there is first-to-the-world innovation. With innovation the world stock of useable production knowledge grows over time; this is the wind of change. This wind shifts the technological frontier, presenting every country with new challenges and new opportunities. The long-term growth rate of innovation may be estimated at 2%, corresponding to the growth rate of GDP per working person in the USA in 1900-2000 (the USA is taken as a benchmark because it is large and stable, and a leader in technology).

Innovation is carried out locally but its diffusion is not country-specific. Every country should have a growth rate that incorporates a 2% component from first-to-the-world innovation. This does not happen. Some countries benefit, but many don't, from the wellspring of technology. The question of access to this wellspring will now be considered.

1.2.1.2. Procuring frontier technology

Any growth process needs technology injections, but the technology needs not to be home made. Even in the United States, the undisputed technological champion, productivity growth relies heavily on people, ideas, firms, and products that come from foreign countries. Many OECD countries are followers; they adhere to the world technological frontier, not by virtue of creation, but by virtue of swift assimilation of technology developed in other OECD countries. According to the estimates of Eaton and Kortum, the United States owes 40% of its productivity growth to foreign R&D, Japan 65% and Germany, France and the United Kingdom between 84 and 89 %. Keller finds that only about 4.7 % of Dutch productivity growth can be attributed to Dutch R&D.[15]

[15] See Keller, W., "International Technology Diffusion", Journal of Economic Literature, vol. XLII, September 2004, p. 776.

As yet, developing countries, with few exceptions, have not forged the ingredients for domestic technological creation. Their lot, then, is to obtain technology mostly through interaction with other countries. The good news is that, as was said earlier, the world is brimming with technology that can be tapped for growth. This world technology can be accessed from three sources.

- First, technology arises inadvertently. There is, of course, the fruit of experience that comes from learning-by-doing. But increasing returns to scale, size, and scope, too, play a role. Given fixed costs and indivisibilities, the introduction of new techniques will be faster when investment grows faster. Inversely, a decrease in the investment rate and a decrease in capital services bring down the overall use of inputs and push upwards the average fixed cost in the economy with a corresponding slowdown of the innovation rate.

  Another source of inadvertent domestic generation lies in the stock of citizens with high education. The average level of human capital magnifies technological productivity; schooling and on-the-job training are relevant channels to obtain human capital.

- Second, there is technology that is out there in a pool that can be tapped, apparently, for free.

- Third, there is the technology placed on the market by firms eager to sell it for profit. These last two categories deserve to be given special consideration.

The (not so) "Free" technology

There is a pool of externalities

The apparently free technology is comprised of the pool of externalities resulting from the accumulation of R&D efforts by private firms. Knowledge being a public good, to a certain extent it bequeaths to technology the properties of a public good. This is why no technology can be confined entirely to the borders of a country (the slow but unstoppable dissemination of military uses of nuclear energy is an appalling confirmation of this assertion). It is also why the very accumulation of technology by private firms, ipso facto, spills over into a public pool. Simulations conducted by Bayoumi, Coe and Helpman (1999) with the IMF's MULTIMOD econometric model have indicated that externalities derived from R&D are pervasive and important. As an example of this importance, the authors calculate that the ratio of the net present values of the increase in US GDP to the increase in R&D spending is 10 to 1.[16]

[16] See Bayoumi, T., Coe, D., Helpman, E., "R&D Spillovers and Global Growth", Journal of International Economics, No 47, 1999, p. 400.

Of course, some technology does not reach the pool (the recipe for Coca Cola is an example, perhaps mythical) and most of the technology that reaches it lands there after a time lag. But the pool is there and seems to be a huge source of potential wealth. It has been estimated that without the international pool of knowledge the world GDP would only be 6% of what it actually is.[17]

Any person, firm, or institution can, in principle, tap this domain. Obviously, this is where a good part of the technical knowledge of developing countries ought to come from. Clearly, developing countries do take advantage of spillovers. However, in this respect they are far from matching the developed countries. Bayoumi, Coe and Helpman found, for instance, that, "If all industrial countries were to raise their R&D investment by ½ of 1% (of GDP), their output would rise after 80 years by more than 17% and the output of developing countries would rise by over 10%."[18]

Why would developing countries, technologically backward as they are, not rely more on free knowledge?

Basically, it is because knowledge is not the same thing as technology. Knowledge is a free good; technology is not. What the pool contains is knowledge. That knowledge has to become technology before it can be used productively. This transformation is costly. It requires investments and expenditures.

Why may this transformation sometimes be very costly?

First, it can be costly because the circumstances of the host countries are very different from those of the innovator countries. Second, it can be costly because the knowledge in the public domain is often fragmentary. Most information products will never reach an entirely abstract form of existence. This is because R&D products, in particular when they are fresh, tend to stick to the people and the organizations from which they are issued. Their form of existence is then a hybrid of tacit knowledge and experience. The problem is that markets can't form around such hybrids because the transaction cost involved in specifying the object of the transaction would be prohibitive. How could the buyer specify and value the implicit supplier's experience that should accompany the explicit information product bought? Hence, hybrid information products are imperfectly tradable. This means that, although technology is a public good, it can only be had with some positive cost, and this seems to also be true in the long term.

[17] See Klenow, P. and Rodriguez-Clare, A., "Externalities and Growth", NBER Working Paper, No 11009, December 2004, p. 44.

[18] See Bayoumi, T., Coe D., Helpman, E., op.cit., ibid.

The marketed technology

The second part of international knowledge is comprised of the technology available on the market. This technology that can be bought, this marketed technology, may be divided in two categories: It can be disembodied – in this case it exists in operating manuals and blueprints, or in people (scientists, engineers, technicians, and managers); or it can be embodied – in this case it is embedded in machines and tools, or in products that can be reverse-engineered.

In principle, there is no particular difficulty in accessing these forms of technology, except, of course, that, unlike spillovers, in most instances one would need to pay to acquire them.[19] The payments do not always go to transactions between buyers and proprietors of technology. Sometimes they go to the costs of reverse engineering, of copying patented knowledge with minor modifications, or of industrial spying. The size of the black market in technology is not known, but it is probably substantial. Most of the time, however, technology is transferred through perfectly legal transactions.

Disembodied knowledge

The disembodied category includes licenses, patents, and royalties.

Can followers acquire this form of technology?

Functioning markets imply not only the existence of buyers but also of sellers. What about the sellers? Would firms that had succeeded in developing technologies want to sell them to potential rivals? Of course they would; actually, licensing agreements with foreign firms are probably the most common way to acquire technology in developing countries. But they would want to do so at a price, and that price makes the acquisition of technology "expensive" because it would include a risk premium and a profit margin.

It ought to be recalled that R&D consists of turning knowledge into an investment from which to earn one's living. This kind of operation is fairly risky because the distance between researching an invention and its realization on the market place is long and uncharted. To place a new pharmaceutical molecule or an Airbus on the market means the immobilization of huge sums for several years. The outcome is quite uncertain because the product development may fail or a rival may cross the arrival line first and seize a good bit of the market. Such risks would not be taken if a commensurate reward were not expected. Hence, a risk premium, a function of the uncertainty of research, would be included. But profit-maximizing firms are not satisfied with a mere coverage of risks. They do R&D because it is a tremendous converter of knowledge into profit. Researchers tend to find that the private rate of return on R&D substantially exceeds the rate of return on capital, even after correcting for the higher risk of R&D. This comes in part

[19] See Baumol, William, J., "Innovations and growth: two common misapprehensions", Journal of Policy Modeling, 25, 2003, pp. 435-444.

from the productivity enhancement virtue of innovation. But R&D does more than simply enhance productivity. It also permits the differentiation of products and, therefore, the exertion of enough market control to allow output production to operate under increasing returns.

Given the pricing features of R&D products, owners of technology have incentives to sell it as long as the price fetched compensates for the loss of earnings that would result from denying access to competitors. These earnings are built on the monopolistic position that knowledge confers on its owner. Hence, in general, the buyer will face prices incorporating risk and profit margins.

What is the growth impact of acquiring disembodied technology?

As yet, it would not seem that research has managed to disentangle the specific effect of disembodied technology on the growth of the buyer. Basant and Fikker found that, in the case of India, the importation of disembodied technologies had a significant effect on productivity growth.[20] Other empirical studies did not find clear causality between purchases of disembodied knowledge and productivity gains or, if any causality was found, it seemed to be conditioned by complementarities between imported technology and local R&D.

Embodied technology

The embodied category comprises knowledge contained in intermediate inputs, machines and equipment and in technical personnel. The two main channels of embodied technology are imports of capital goods and FDI.

Technology embodied in Foreign Direct Investment

FDI flows are on the increase in the world. The recent acceleration of FDI has to do with the removal of discriminatory measures against it in a good many countries. The basic reason why countries have removed these barriers is that FDI is coveted for the sake of its "special" contribution to growth. Clearly, the principal reason countries compete in terms of incentives to attract FDI is that it is an addition to the capital endowment of the host country. But, of course, there is more to it than that. Governments try to attract FDI because it is assumed that it will have positive effects on the whole host economy. FDI is supposed to be a catalyst of spillovers. Speculatively, several channels can be invoked. In the first instance, FDI is thought to transmit spillovers by demonstrating a superior technology to domestic firms. There are also more

[20] See Basant, R. and Fikkert, B., "The Effects of R&D, Foreign Technology Purchase and Domestic and International Spillovers on Productivity in Indian Firms", Review of Economics and Statistics, 1996, pp. 187-199.

indirect effects, for instance, in hiring personnel and buying inputs or intermediate goods. To the extent that these interventions in the factor market of the host country are different from those of local firms, the purchases made by FDI may indirectly affect the production conditions of domestic firms.

If a multinational creates stronger linkages with domestic suppliers than domestic firms would do, then the domestic economy as a whole benefits through a wider variety of specialized inputs. However, negative effects can just as easily be conceived. It is perfectly possible, for instance, that the superior technology of the multinational will harm local firms. Another open question is how sizable, if any, is the impact of spillovers on the productivity of the host country and, in particular, if this impact is capable of justifying the price many governments seem ready to pay to attract FDI.

When and why FDI generates externalities depends upon particular circumstances. In our country studies we have examples of multinationals wiping out local rivals. But other narratives report cases of multinationals that first induced local industrial development being later wiped out by strong competition from local rivals. In Mexico it would seem that multinationals simply do not affect local firms. All they do is use Mexican labour to assemble goods for export.

The evidence is that foreign-owned firms are more productive than their domestically-owned competitors. But the impact of this on average national productivity is unclear. There is much to be said in favour of general productivity enhancement through FDI. In a number of countries, domestic firms in manufacturing sectors with a relatively strong FDI presence will be more productive than the average domestic firms in the manufacturing sector.

This often observed fact is, however, subject to causality interpretation. What if foreign-owned firms go precisely where firms are more profitable? Profitability is not the same thing as productivity but, for want of observations on real inputs and outputs, many studies take value terms as surrogate. That makes it difficult to dissociate profit (resulting from, say, market power), from productivity (resulting from technology *cum* efficiency).

Furthermore, in at least one of the country case studies, domestic firms do worse in the presence of foreign-owned firms (because the foreign-owned firms crowd out domestic demand and the supply of high quality labour).

Technology embodied in imports of foreign capital and intermediary goods

Decision-making in matters of technology, in particular regarding the question of imported versus homemade technology, must be approached in the broader context of the integration of the host-economy to the rest of the world. This is not a merely speculative view; it is a view deeply rooted in the examples of technological success recorded in developing countries over the last half century.

The art of using trade for growth has been revealed in practical ways by Japan, South Korea and the Asian Tiger countries. One starts with specializations in what one does well, like rice growing, tourism, garment making – in general, labour-intensive specializations. The exports of these goods initially serve the accumulation of the physical capital to push production as far into decreasing returns as is compatible with competitiveness. From there, progressively, one looks for more capital-intensive activities and the returns on exports are used to pay for learning how to deliver more sophisticated goods and for acquiring the inputs and machines needed for that purpose. Surfing from specialization to specialization in the direction of capital intensity, one ultimately lands on the world technological frontier where state-of-the-art goods are produced with state-of-the-art techniques.

This growth model might, perhaps, look like capital accumulation (hence exposed to decreasing returns) combined with shifts in the composition of output (to escape from decreasing returns). Apparently there is not much room for productivity in such a scheme. But, actually, there is more productivity in this model than meets the eye. First, productivity sneaks in through learning-by-doing. Within each specialization the very experience accumulated in repetitive operations provokes an inadvertent improvement of performance. Second, the introduction of new capital goods in the production process has an important by-product: it generates technical change. Capital goods of more recent vintage embody the technological progress achieved in the country of origin. This progress enters the productive process as the capital good is put into operation. Third, the recourse to foreign suppliers of inputs expands the choice of inputs available for production and augments, correspondingly, the chances of finding the assortment most appropriate to the relative scarcity of domestic factors.

In addition to productivity, the model in question brings in a scale effect: World exports introduce a scale effect on sales. With productivity gains in production and with the world market in sight, R&D might become an option even for small countries. Our collection of country cases studies exhibits an indisputable growth champion: South Korea (not to speak of Malaysia, Singapore, Thailand, Hong Kong, and others that are not in our collection of case studies). The trajectory followed by South Korea matches quite well the growth model sketched above: Start with a specialization in relatively low-tech products but do these products well enough to conquer world market by using the best technologies and inputs that imports can provide. Then move progressively towards higher-tech products, using the returns of exports to acquire ever better capital goods, inputs and technologies.

The South Korean lesson is clear: Knowledge and technology are out there, and it seems that there is nothing like deliberately cultivating links with international suppliers and clients to make the most of them. Countries that adopt these prescriptions will automatically discover the right signals about what is best for them in matters of knowledge acquisition.

The model discussed above is sequenced. It starts from grass roots specialization, then climbs to state-of-the-art through close contacts with the world's best suppliers and customers. The condition for such a model to work is to start from scratch. South Korea started her economic career from a state of utter desolation (no doubt with some initial human capital bequeathed from colonial times but with nothing in the way of accumulated experience or physical capital) and so did the other Asian Tigers. It will be good to recall this condition when we come across countries trying to follow the Asian example but from an intermediate stage of development. Argentina, Brazil, Chile and India, for instance, have tried to start with sophisticated goods made with their own intermediate and capital goods. This did work over the medium-term because of the dynamics of inner linkages, but it failed utterly over the longer-term because the sophisticated final goods could not be world exports, and, therefore, world-class imports could not be afforded.

1.2.1.3. Generating domestic technology

Domestic versus foreign technology

UNIDO is an agency focussed on developing countries and, in particular, on the less developed among the developing countries. It has been said above that the overwhelming bulk of R&D takes place in OECD countries. Why then all the fuss about R&D? The answer is that we understand by R&D expenditures all those expenditures made to introduce techniques new to the country. Expenditures on innovation is the purest form of R&D technology, but expenditures also on the adaptation of imported technologies, are R&D expenditures in our use of the term. As seen above, a technique is not simply brought by the wind to become operational in the receiving country; it requires resources devoted to learning, training and re-organization. These resources are financial but also include the skilled labour that uses knowledge to set the imported technique on the best productive mode. Even though these resources are not devoted to innovation in the rigorous sense of the word, they are distracted from purely productive use for the sake of installing a technology new to the country. Adaptation is therefore quite akin to innovation.

What is the current status of R&D in developing countries?

It may be surprising but, actually, all countries, even the very poor ones, do some R&D. This statement is, however, to be qualified in three respects. First, in poor countries R&D is relatively less important than in developed countries. Second, the accent is placed more on the

implementation of technologies developed elsewhere than on innovation. Third, R&D is less ostensible than in developed countries (informal development within firms is the norm; formal R&D in specialized institutions or laboratories is the exception). Notwithstanding the prejudice that it is absent in developing countries, the question of R&D is entirely pertinent even for the poorest country. With one or two exceptions, there is no country so backward that technology is not present in the countryside in the form of agricultural stations, mining, energy, animal husbandry, and tourism and, in the cities, in the form of commercial malls, automatic bank tellers, and telecommunications.

Technology is deliberately generated by the efforts of individual innovators and by the research of private firms. But it is not very visible because incremental adaptation of technology cannot be easily discerned from mere productive processes. As mentioned above, non-business actors (specialized schools, universities, publicly-financed research, laboratories) have more visibility as the level of development of the economy increases. However, in developing countries there is still a whole gamut of activities that procure international technologies, engage in their costly adoption and costly adaptation; these activities truly constitute an R&D sector.

But, in general, developing countries report that their R&D efforts obtain disappointing results. This is also reflected in the country studies made for this book (among the 15 cases, only South Korea seems to be, on the whole, satisfied with her technological capability).

The causes of inadequate R&D in developing countries are manifold

One cause, often mentioned but seldom documented, lies in the threshold placed on the size of national expenditures by R&D indivisibilities. It seems that R&D begins to pay off only above a level of expenditures that outstretches domestic budgets. Observers of R&D in developing countries would say that R&D is under-financed.

Another cause is the lack of coordination of national efforts. A national system of innovation seems an unreachable grail in developing countries. There are institutions a-plenty in the public and private sectors, but they do not work together.

Third, low performance may have to do with the uses R&D funds are put to. A wrong orientation of efforts is claimed to be the culprit. Orientation is here understood in a space of many dimensions. It may be orientation according to the axis private-public user of funds (usually too much public sector or not enough private sector). It may be orientation according to the fundamental-applied axis (too much fundamental not enough applied). In some cases publicly financed research goes mainly to "financing academic stars with a foreign Ph.D." (See the country case study of Chile), with very little resulting impact on technology. In other cases R&D results in innovations, including of the new-to-the-world kind. It may also be an orientation on the axis large-small firms. Small firms have a role to play in matters of innovation. There is evidence that in developed countries innovation depends very much on small firms (firms that are created precisely to place an innovation on the market). Maybe it is

not the same in developing countries; this we do not know, but perhaps it could be the same if more attention were given to the innovative potential of small firms.

It may also be an orientation according to sectors. It is noteworthy that, in the same country, R&D can be excellent in some sectors and mediocre in others. Since the 90s globalization (opening the doors to the influence of comparative advantages) and privatization (allowing these influences to leave their imprint on the productive structure) have tended to decrease the local manufacturing R&D of Latin America compared to the imports substitution period. But in other sectors R&D gains intensity. In Chile, for instance, collectively financed R&D on non-excludable applications like fruit, salmon and wine provided state-of-the-art results in the hands of private companies.

Fifth, the link between R&D and performance passes through complementary factors. One well-known requirement for domestic R&D to be productive is the country's endowment with human capital.[21] But many other factors come in line too. The labour market, financial intermediation, incentives, and firms are only examples. As a general rule it seems that countries further from the frontier have lower R&D returns. In other words, it would be relatively more expensive for a poor country to innovate than for a rich one.

If one goes by the country case studies, what is important in explaining the expansion of domestically generated technology is rapid investment growth, rapid growth of education and training, improvements in the interdependence with other countries (examples include better personal security for foreigners; cheaper telecommunications; removal of trade barriers; enhanced property rights; improvement of the transport infrastructure; and access to outside knowledge). High taxes and high inflation are bad. Macroeconomic stability does not seem to entice technological expansion, but a lack of stability has strong negative effects. Performance in innovation seems to be stimulated by foreign direct investment, R&D, licensing and human capital.

What matters most, though, is the right cocktail of these factors. The dosage of this cocktail would depend on the relative cost of factors and on the product mix of the economy. For instance, in Latin America, a region rich in natural resources, an intermediate level of R&D may be appropriate given that natural resources tend to be less R&D intensive. Today, the Latin American cocktail is comprised of weak R&D, relatively weak labour "tertiarization", relatively strong foreign investment, and some licensing. South Korea and China combine above-average doses of R&D with very small doses of technology channelled through foreign direct investment.

[21] See Nelson, R., and Phelps, E., "Investment in Humans, Technological Diffusion, and Economic Growth", American Economic Review, vol. 56, 1966, pp. 69-75.

The issue

It is clear that, with globalization, international knowledge is now diffused more fluidly than in the past. This trend provides an opportunity for all countries, including the poorest. It may even be assumed that the poorer a country is, the more valuable it is for it to be linked to the international pool of knowledge. This assumption is inspired by international trade theory. Given that their research intensity is lower than in rich countries, poor countries ought to benefit more from the world pool of knowledge than do rich ones. But collecting international knowledge is of no use if it is not transformed into technology. It follows that globalization ultimately appears as an invitation to poor countries to develop a greater technological generation capacity at home than in the past.

However, a latecomer-argument may be invoked against the trade-derived one. Poor countries ought not to engage in a vertical integration of the stages of developing new-to-the-world technology. What they mostly need is to absorb mature technology. Granted, international technology does not come cheap, but it is still cheaper for a latecomer to buy the technology already invented by others than to re-invent the wheel.

This argument rests on two points. One is the advantage of backwardness. Backwardness is the situation of a country well behind in terms of technology. Such a country can make a lot of progress by merely catching up, i.e., without innovating. The other point is that the cost of innovating is proportional to backwardness. Innovating is relatively more expensive for countries currently at low levels of productivity. Inversely, investing in technologies that have been developed elsewhere but are better than the ones currently in use is relatively cheaper.

There is no need to take either side in this argument. The two options are not mutually exclusive; on the contrary, they can be combined. The only question here is to find the right proportion: In total investment what share should go to innovative activities and what share to imitative activities? But it is an important question. It is a thesis of this book that, for a poor country, the most central policy issue in the realm of technology is to what extent to invest in domestic R&D, given that there are opportunities to acquire imported technologies.

An episode of the Argentinean conversion to openness may illustrate the kind of friction that can occur between imported technology and domestically generated technology.

When Argentina changed her course, she was a country already engaged in her own production of intermediate and capital goods. There was a modest R&D sector (engaging16,000 persons) generating incremental innovations in the most advanced sectors. However, R&D was to be supplemented through learning-by-doing in the intermediary sector.

The source of learning-by-doing was the efforts of specialized engineers and technicians to draw improving lessons from the current production practices. The fruit of learning-by-doing was new and more productive varieties of inputs. The productivity of learning-by-doing varied according to the sector of production. To simplify, it may be said that it was less productive in

the process of producing simple intermediates, and vice-versa. Producing simple inputs, e.g., textiles, induced a modest learning-by-doing effect while producing sophisticated inputs, e.g., gearboxes, induced a stronger effect. In sum, the total technological progress depended on the number of people in R&D and on the structure of the intermediary sector in terms of simple and complex intermediary goods.

In this kind of setting what pitfalls should policy makers watch out for when initiating a strategy of technology imports? When the country opens up, the rest of the world presumably enters the domestic scene with inputs that are more productive than those of the host economy. What could happen?

There are extreme scenarios such as one in which the imported inputs wipe out all the domestic production of inputs. But there are also more subtle scenarios. For the sake of realism, and also to show how the dynamics of technological development is sensitive to particular conditions, let us consider an example of the latter.

First, suppose the rest-of-the-world inputs evict the simple host-economy inputs. In this case, all the R&D personnel of the host economy are redeployed to the production of the sophisticated host-economy inputs. Since the learning-by-doing effect is more powerful in sophisticated inputs, technological development would be enhanced in the host economy. But the more realistic assumption is that the rest-of-the-world inputs would crowd out the sophisticated inputs of the host economy (this is the most realistic assumption because the field of application of these imported technologies is more likely to be in the most advanced inputs of the host economy). With this second scenario, the incentive for the host economy to do its own R&D is jeopardized. Every time the host economy would plan to come up with a new variety of inputs, implementation would be deterred by the menace of imports from the rest of the world. The labour force in R&D would shift into activities with lower learning-by-doing effects, and the economy would engage in an unlearning path.

Sketchy as this scenario might be, it is not entirely far-fetched. Having discovered how slow the growth of total productivity of factors has been in Singapore, Young hypothesized that in this city-state technological progress had been blocked by a policy of systematic imports of capital goods. Similarly, the case of Argentina in the late 90s gives the impression that an important source of domestic technological progress was jeopardized when the automotive sector was radically modernized by allowing it to import inputs from the rest of the world. This wiped out the local automotive parts-and-pieces sector, where technological progress by adaptation had been going on for many years. It is right to take advantage of globalization to bring inputs of the highest world standard into the country, and Argentina was certainly well inspired when it imported basic foreign technologies in generic inputs with little learning-by-doing; but allowing the eviction of the automotive parts and pieces, where learning-by-doing was a source of intense externalities, may have caused a larger than expected loss.

1.2.2. Building human capital

Intuitively, we perceive human capital as one of the determinants of productivity. How do these channels operate? The variable of human capital has been emphasised since early neo-classical explanations of growth. In the neo-classical view, the accumulation of human capital, like that of capital, allows a better use of the available technology and capital stock. It is clear that the better trained, the more educated, and the more experienced that workers are, the more productive is the use that society can make of capital. It is clear, also, that human capital is needed to man the R&D system, which, in turn, is the source of technology. The marginal return on capital is decreasing; the exogenous flow of technology is constant. The only way to keep GDP per capita growing is, therefore, to increase the level of human capital. As technical progress is exogenous, one burst of human capital cannot have a growth impact. It would increase the level of GDP per capita for a while but, soon enough, the decreasing return on capital would take that gain away. Growth must be fostered with a continuous increase in human capital.

However, the idea that the growth rate of human capital is what keeps the growth rate of GDP going does not hold water. Pritchett has shown that in developing countries the second half of the twentieth century has seen a combination of strong enrolment growth and decreasing GDP growth.[22] It has been noted that in the United States the SET personnel engaged in R&D have grown almost nine fold since 1953 with no significant increasing trend in productivity growth.[23]

However, the advent of endogenous growth suggested that there is a dynamic interaction between technology and human capital. That would mean that the stock of capital, more than the growth rate, is the factor that plays on GDP per capita growth. Admittedly, the contribution of Benhabib and Spiegel[24] was probably a little radical in denying an impact of the growth of human capital on GDP growth, leaving entirely to the stock level the responsibility of impacting GDP growth. But, later on, better data and better indicators allowed Krueger and Lindhal to establish a significant role for both the level and growth of the human capital stock.[25]

In both of these two articles one can find indications that the correlation between the stock of human capital and GDP growth is stronger for developing countries than for developed countries (in Krueger and Lindhal it actually peters out for OECD countries).

This indication is intuitive (the difference between enrolments of 5% and 10% has more

[22] See Pritchett, L., "Where Has All the Education Gone?", World Bank Policy Research Working Paper 1581, World Bank, Washington, 1996.

[23] See Jones, C., "R&D-Based Models of Economic Growth", Journal of Political Economy, No 103, 1995, pp. 759-784.

[24] Benhabib, J., and Spiegel, M., "The Role of Human Capital in Economic Development: Evidence from Aggregate Cross-Country Data", Journal of Monetary Economics, 34, 1994, pp.143-173.

[25] See Krueger, A., and Lindhal, M., "Education for Growth: Why and for Whom", Journal of Economic literature, vol. 39, No 4, 2001, pp. 1101-1136.

explanatory power than a difference between 90% and 95%) but it is confirmed, as will be seen in Chapter 4 on policies, at the microeconomic level. If confirmed, the dynamic property of interaction between social and individual human capital would bode well for the future of developing countries. Most of mankind lives in developing countries, and this dynamic property would have the size of the population permanently affect the growth rate of the economy. For the time being, human capital is, on average, still limited in developing countries but it is increasing fast. In Africa between 1960 and 1994 the average years of schooling increased from 1.6 to 3.5, in East Asia from 2.7 to 7.2.[26] When the individual level of human capital enters the neighbourhood of what it is in advanced countries, the productivity spiral will, in principle, effortlessly lift the growth rates of populated countries (for example, China, Brazil, India, or Indonesia) over the achievements of developed countries. In principle, that is, because, as said earlier and as will be seen in the following pages, there is no strong empirical support for the view that scale effects are actually at work.

1.3. The utilization of the technology potential

Introduction

Productivity comes from technology. The determinants of technology – or the sails that capture the wind of technological change – are R&D and human capital. The interdependence does not stop there. Like Russian dolls, the proximate determinants are themselves wrapped in more distant determinants. To make technical change a reality, technology must meet at least three prerequisites in the material world: an enterprise willing to take the risk and capable of operating a new technique; personnel with the required competence to work for the enterprise; and a market capable of remunerating the factors employed by the enterprise. Furthermore, the firms must find the right incentives, and these will have to come from the labour market, from the cost of capital, from the size of the markets, from the competitive structure of the markets, from the infrastructure, and from the property rights.

Together, these prerequisites are almost coextensive with economic development itself. It is only exaggerating a little to say that technology brings about economic development, but it takes nothing short of economic development to bring about technology.

The accumulation of tangible factors, like capital and labour, defines the place of a country in a technological stratum. This stratum offers a certain range of feasible technical solutions. The proximate determinants are decisive in setting the technology potential of the country to mobilize this range of solutions. The more distant determinants – or the rigging that defines how the sails, masts, and so on are arranged – are decisive in setting the degree of utilization of this potential. What, then, are these determinants?

[26] See Collins, S., and Bosworth, B., "Economic Growth in East Asia: Accumulation versus Assimilation", Brookings Papers on Economic Activity, No 2, 1996, pp. 135-203.

1.3.1. *Sorting out the distant determinants*

In this book the question of listing the distant determinants is approached from different angles. First, we did a review of the pertinent literature published since 1990.[27]This literature analyses and discusses a whole gamut of determinants. Five broad categories draw the attention of researchers; these include the proximate determinants discussed above:

a) The fruits of knowledge and experience: the creation, transmission, and absorption of technology, and learning-by-doing, scale economies, capacity utilization, and spillovers
b) The results of accumulation: factor supply and allocation
c) The deeper level: invariants, integration and institutions
d) The factors that also matter: competition, the social dimension and environmental concerns
e) The specifics of a country

In what follows we delve into the last four categories to extract the distant determinants that are potentially involved in setting the utilization of the productivity potential. We listen to what the literature has to tell us about what these determinants can do for productivity, and we confront the results in the concrete experience observed in 15 developing countries. This country evidence is provided in analytic narratives by UNIDO national experts.

The 15 countries that have been selected for the country case studies arranged by region are:

Latin America and the Caribbean region: Brazil, Mexico, Chile and Argentina
Arab region: Egypt and Morocco
Africa region: South Africa, Nigeria, Kenya, Tanzania, and Uganda
Asia region: China, Republic of Korea, India and Indonesia

This material is set against the predictions made by the literature in order to contextualize how the determinants transmit their influence on productivity. The hope is that we will learn something useful for policy-making.

1.3.1.1. Factor supply and allocation

Cross-country regressions

According to the literature, public capital, in particular in the form of infrastructure, has an important effect on TFP growth and there is even some evidence of causality running from infrastructure to growth. Research has also addressed how public investment is financed, and it

[27] See Isaksson, A., "Determinants of Total Factor Productivity: An Assessment of Recent Evidence", UNIDO Working Paper, forthcoming, Vienna, 2005.

seems that an allocation of public expenditures is preferred to an increase in public debt. The crowding out of private capital formation does not seem to be of great concern. Instead, the management of public capital has been proven to be very important, suggesting that institutions matter strongly.

We have not been able to find strong empirical effects of structural change on TFP growth, although there were certainly indications pointing in that direction. Yet, decomposition exercises show that most productivity growth comes from within-industry and within-plant effects. However, the results of one study suggest that market frictions hinder the economy's ability to efficiently allocate output and inputs across businesses. In terms of firm turnover dynamics, net entry seems to be important, with entrant plants being more productive than exiting ones.

Finally, although based only on a few studies, there is strong evidence for the idea that financial development is good for, and financial repression bad for, resource allocation, capital accumulation and the incentive structure. Financial development was also shown to matter for the speed of convergence through its effect on TFP growth.

Country studies

Accumulation of physical capital is important but, interestingly, the highest accumulation occurred during the import-substitution phase, not post-liberalization. Worsening fiscal conditions have reduced the quality of infrastructure in Brazil, while in Chile the stock of infrastructure has increased rapidly. The effects on the two countries' TFP have been negative and positive respectively. Except for Chile, the financial system in this region appears quite undeveloped. This fact has worked as a constraint on TFP growth.

The Asian region is also performing well in terms of physical capital. An interesting difference between China and South Korea, on the one hand, and Indonesia, on the other, is that the latter funded investment with foreign capital while the former used domestic capital. This made Indonesia much more vulnerable at the time of the Asian financial crisis. Hence, it also matters how investment is funded. China has reformed its financial system and this has greatly improved the efficiency of funds allocation, as evidenced by a higher average profit rate. Another contributor to TFP growth in China and South Korea has been structural change from agriculture towards manufacturing.

In the Arab region, the lack of infrastructure has been one of the factors behind slow economic growth in the case of Morocco: it is mainly the kind of services that seems inappropriate. In Egypt, investments in infrastructure have increased and have contributed significantly to TFP growth.

In African countries a difficult business environment has had negative effects on capital accumulation. In addition, the capital stocks tend to be of old vintage and low quality. Poor infrastructure conditions coupled with the high cost of its services have had a negative impact

on TFP growth in all the sampled African countries. In fact, infrastructure has been identified as one of the main constraints on productivity performance.

To summarize, the country studies have been able to reveal that the explanation for poor infrastructure may be found in lax fiscal discipline. They have also shown how a lack of education and an undeveloped financial system can hold back TFP growth.

1.3.1.2 Institutions, Integration and Invariants

Cross-country regression

Starting with macro-based studies, the trade-TFP growth literature has received a lot of criticism, in particular for not properly addressing statistical problems, such as endogeneity bias, and for omitting institutions and geography from the analyses. Correction for endogeneity and the inclusion of institutions and geography have had a tendency to render total trade statistically insignificant. One component of trade, imports, was however shown to be robustly associated with productivity. From the micro literature we have learnt that there is a great deal of heterogeneity in the data. For example, there was evidence that trade liberalization has a greater impact on large plants and in industries where competition is low. Furthermore, it is mainly relatively unproductive firms that benefit from trade liberalization because they have to either improve or exit. Relatively productive firms suffer less from increased pressure because they have a buffer. Trade liberalization was also shown to positively affect access to foreign capital (read technology) and to lower its price. We found that the import effect shows up in the micro data as well. On the export side, it seemed that learning effects were very small or non-existent, and there was even evidence suggesting that causality runs from productivity to exporting. We concluded that trade openness (as a policy) is important and that, in terms of outcome, it is imports that matter for TFP.

In the case of institutions, a division was made between political and economic institutions. The results for the former were very inconclusive. However, there were some indications that democracy/economic freedom may indeed promote TFP and has a negative effect on capital accumulation, but that the net effect on overall growth is positive. With economic institutions, there was overwhelming evidence favouring the notion that institutional quality has a strong positive effect on the productivity level and its growth rate. In empirical work focused on the long-term, institutional quality tends to "kick out" trade, while geography (invariants) remains.

A follow up question we asked was why some countries seem to keep institutions that are apparently bad. One suggestion in the review was that some powerful groups benefit from the situation and have no interest in policies that would alter it. An interesting result was that the strength of the institutions might actually depend on the quality of human capital.

"Poor" geography was shown to clearly affect the enjoyment of the fruits of technology transfer, and this obviously impacts on TFP growth. Some evidence suggested that geography might work entirely through its effect on institutions, but there were also indications of direct effects.

Our overall conclusion was that these three determinants, institutions, geography and imports (but not trade as a whole), exert strong first-order effects on TFP growth.

Country studies

In Latin America, the poor institutional structure, possibly traced back to wealth-human capital-political power inequality, was seen as a key impediment to TFP growth. These countries have had mixed experiences of trade liberalization, where most of the productivity benefits have come from the imports side. However, in this case trade liberalization implied increased competition from imports rather than increased imports of foreign capital or learning from importing.

Box 1: Effects of NAFTA on Mexican Economy and Productivity

There have been two recent evaluations of the overall effects of NAFTA on the Mexican economy in general, and on the country's manufacturing productivity performance in particular. The first study argues that liberalization of trade facilitates the convergence of TFP levels, even when production technologies differ across countries.[28] As a result, this study tries to identify the impact of the agreement on income and productivity gaps in North America, especially between Mexico and the U.S.

The authors use various methodologies to assess NAFTA effects on income and productivity differentials. Easterly et al. (2003) use time series exercises to separate transitory effects from long-term effects, and apply co-integration analysis to examine whether there is an observable process of income convergence between the United States and Mexico. They find that the debt crisis in the early 1980s and the *tequila* crisis temporarily interrupted a process of economic convergence, which resumed after 1995, i.e., following the signing of NAFTA. This, however, is an inconclusive finding.[29] In the same paper, the authors also study the impact of NAFTA on TFP differentials within manufacturing industries across the U.S. and Mexico. Based on a panel estimation of the rate of convergence across twenty-eight manufacturing industries, they find a substantially faster rate of productivity convergence after 1995 than in previous years, and thus conclude that NAFTA has had favourable effects on the Mexican productivity performance.[30]

[28] Easterly, W., N. Fiess and D. Lederman (2003), "NAFTA and Convergence in North America: High Expectations, Big Events, Little Time", *Economía*, Vol. 4, No 1 (Fall).

[29] In effect, this result has been severely challenged by Weisbrot, M., D. Rosnik and D. Baker (2004), "Diez años del TLCAN: el recuento", Economía-UNAM, Núm. 3, Septiembre – Diciembre, who show that the econometric model used to quantify the favourable effect of NAFTA gives different results when applied to authorized economic series (the Penn-World tables or OECD data). In such a case, the result is the opposite, i.e. NAFTA seems to have contributed to economic divergence instead of stimulating economic convergence between Mexico and the USA. These different results can solely be attributed to errors in the construction of the series utilized by Easterly, Fies and Lederman (2003).

[30] They did not hypothesize, however, on whether productivity convergence was the result of increased imports of intermediate goods from the U.S., competitive pressure and preferential access to the U.S. market, or increased Mexican innovation resulting from a variety of factors and patenting aided by enhanced protection of intellectual property rights under NAFTA.

The second analysis was presented recently by López-Cordova[31] (2003). In it, the author studies the degree to which NAFTA has affected TFP in the Mexican manufacturing sector. He measures TFP using a panel of manufacturing plants spanning the 1993-2000 period to address the possibility of sample selection and simultaneity problems in estimating production functions that use panel data. In this way the author quantifies TFP levels and evaluates the impact that the dismantling of protectionist barriers and the rise in foreign manufacturing operations in Mexico have had on plant productivity performance. He also looks at the role of the reallocation of resources in explaining productivity improvements.

The main results of this thorough evaluation are:

- Increased import competition in the 1990s played a major role in improving plant efficiency. Mexican tariffs have a negative and significant impact on both the level and the growth rate of productivity. In addition, an increase in the ratio of imports to output in a given industry is also negatively and significantly correlated with the level and growth rate of productivity.
- Preferential access to U.S. markets for Mexican goods has a positive impact on plant productivity.
- Mexico's exports do not have a positive effect on plant productivity growth. Exporting has an important role, however, in allocating resources to more productive firms and industries, therefore raising allocative efficiency.
- The use of imported inputs in the production process seems to have an adverse impact on productivity growth, especially amongst foreign firms.
- Finally, since NAFTA had a positive impact on incoming capital flows, it is important to distinguish between intra-industry spillovers – within the same industry – and inter-industry spillovers that occur as FDI pours into downstream or upstream industries in the production process. The result is clear:
- A foreign presence adversely affects productivity among producers in the same industry, but the inter-industry impact is positive through both backward and forward linkages. However, the net effect of all three effects is undetermined.[32]

Therefore, it seems that the substantial liberalization of trade and investment in the Mexican economy in the 1990s, which was largely driven by the implementation of NAFTA, has considerably enhanced *manufacturing* productivity. There are, however, some qualifications to this assertion. In the first place, as Esquivel (2003) has suggested, it is clear that the database used in these exercises is not representative of the whole manufacturing industry in Mexico, but rather is biased towards medium-sized and large firms, which implies that we cannot easily draw inferences for the whole population from these data. Second, not all trade-induced productivity gains based on learning entail the transmission of knowledge regarding

[31] López-Córdova, E. (2003), "NAFTA and Manufacturing Productivity in Mexico", *Economia*, Vol. 4 No 1 (Fall).

[32] In a separate piece of research, using the same data set of Mexican manufacturing at the plant level, Domínguez-Villalobos and Brown-Grossman (s.f.) find that, even though foreign-owned firms show higher levels of TFP than Mexican-owned firms, these productivity differences do not guarantee by themselves that foreign firms generate positive spillovers on Mexican firms. After a thorough investigation of this issue, the authors conclude that spillover effects require a series of factors that have been absent in the Mexican export-led model of development. The generalized technological backwardness of local plants prevents the generation of externalities from FDI, given that generation of knowledge requires the coordinated action of different actors of society: federal and local governments, universities, research centres and, of course, Mexican entrepreneurs. Fujii-Olechko (2004), using a different data set, finds that foreign-owned firms have a positive effect on productivity because of their own higher levels; however, he finds no statistical evidence on the presence of positive externalities on Mexican-owned enterprises. To him, the mechanisms for the transmission of spillover effects are simply absent from Mexican manufacturing.

production processes. Moreover, if learning is costly, then trade and FDI alone may not automatically lead to a substantial development process based on learning. In the third place, NAFTA might have helped spur trade and economic growth, but the trade benefits were mainly driven by the reallocation and factor accumulation effects. Also, FDI was probably stimulated by NAFTA and Mexico's economic recovery, but it did not necessarily lead to enhanced learning capacity in Mexico's private sector.

For our purposes it is important to stress, however, the distinction between the effects of NAFTA on manufacturing industry, on the one hand, and the probable effects on the Mexican economy as a whole, on the other. In the latter case, it is useful to recall that the evidence on the possible convergence path followed by the Mexican economy in relation to the U.S. economy after the implementation of NAFTA has been severely questioned by Weisbrot et al. (2004).

All in all, there is nothing to indicate that NAFTA has had positive effects on Mexican productivity performance at the *aggregate* level, apart from the possible favourable effects on medium and large-sized enterprises in the manufacturing sector. NAFTA effects on productivity, therefore, have been extremely localized in terms of efficiency and productivity gains, contrary to the common beliefs of NAFTA advocates.

Positive results from liberalization were enjoyed by Argentina (increased imports and competition effect) and Chile, while Brazil and Mexico performed worse than during pre-liberalization. In the positive case, it is not entirely clear that it was trade policy per se that did the trick, as trade openness was part of an overall reform package. In the case of Brazil, imports do not seem to have increased enough to "threaten" domestic producers. In Mexico there were too few large companies for the country to really benefit from foreign technologies. Interesting exceptions to the total-economy picture in Brazil and Mexico occurred in their respective manufacturing sectors, where in both cases TFP increased.

For the Asia region, the Indian case study suggested that the most critical determinant of TFP performance has been the change in the incentive structure. This in turn resulted from changes in the institutions that drive the growth process. With a new incentive structure in place to reward productive investment, the result was stronger competition and a greater degree of integration (thus suggesting that integration is a function of institutions!), both of which have improved TFP growth. South Korea has successfully integrated into the world economy. In this, their export-led industrialization strategy has been important. For China, increased openness has meant a large number of advanced technologies, this through international trade. India's lack of openness has hampered TFP growth. Some recent opening up has reduced this disadvantage but the country remains relatively closed.

In Africa, the Kenya study showed that it has done well in terms of integration, and this is likely to have had a positive impact on TFP growth. In South Africa trade openness increased competition. Furthermore, because it lacks navigable internal waterways and most of its industry is located far from the coast, South Africa has suffered from high transport costs that have exerted constraints on export-oriented industries and imports dependent on imported inputs. In the case of Uganda it was argued that it has faced difficulties in fully participating in the global economy because it is landlocked.

In the Arab countries, Morocco has worked hard on the integration side, but, since this has been quite recent, it was too early for an evaluation. Furthermore, integration seems to have mainly involved capital goods, while other tariffs have remained high. The Egyptian country study argues that that country still lags behind in terms of international integration.

The country studies have shown that different institutional structures have an impact on TFP performance. They also corroborate the finding of the Review that importing is the important trade component, this mainly due to its increased-competition effects. Geography does not seem to be a great issue for the 15 countries,

1.3.1.3. Competition, Social Dimension and Environment

Cross-country regression

Empirically there was mild evidence in favour of privatization, for example, former state-owned enterprises tend to increase their performance after privatization. Empirical results also suggested that stringent regulatory settings in the product market decrease productivity. One conclusion drawn is that competition is very important for TFP growth.

Country studies

In Latin America, the import-substitution strategy has largely been abandoned but the effects of the move towards greater competition have differed across countries. Privatization in Chile has been successful because it ensured the abolishment of state protected monopolies whereas in Mexico and Argentina it was less successful because its goals were not to increase competition but rather to maximize state income (Mexico) or reduce state-owned companies' inefficiency (Argentina). All countries, except Brazil, experienced problems with privatization, the main one being the shift from state to private monopoly, in which competition cannot play its role.

Box 2: A Note on Regulatory Reform in Brazil[33]

Until the mid-1980s, ownership of state firms and the economic policy of the military regime made economic regulation of lesser importance. In key sectors of the economy, such as infrastructure and finance, state-owned enterprises (SOEs) were dominant, and 'regulation' was exercised through the appointment of the main executives of SOEs. Whenever present, regulatory agencies were weak and 'captured' by the firms they were supposed to control. In most other modern sectors, the state controlled much of the private sector's investment through fiscal and credit incentives, tight entry controls, and direct supervision by sector ministries and agencies.

The return on democracy, and the state retrenchment that followed, called for a new regulatory apparatus. The same may be said of price stability and the need to achieve fiscal discipline, which required institutional changes and imposed limits to former regulatory practices that depended on access to fiscal subsidies. Most sectors in the economy have been subjected to some kind of regulatory reform in the last two decades.

[33] Taken and adapted from Pinheiro, A., Bonelli, R., and Schneider, B., "Pragmatic policy in Brazil: Political Economy of Incomplete Market Reform", Texto para Discussao No 1035, IPEA, Rio de Janeiro, August 2004, pp. 21-22.

Since the 1990s Brazil has been adopting initiatives to increase competition in domestic markets by freeing firms and markets from controls introduced during the ISI phase, and by strengthening competition agencies. A first set of measures was implemented by the Federal Deregulation Program: no less than 113,752 presidential decrees were revoked, from a total of 123,370 decrees issued in the previous 100 years. Other initiatives included the end of public monopolies in exporting and importing certain staples; the end of prior approval to export and import certain products (steel, for instance); the reduction in the minimum national content level for a project to qualify for public credit; a reduction in the red tape in citizens' lives, with a substantial simplification of documentary, tax, and utility billing procedures; and an overall simplification of foreign trade paperwork. Yet, despite the simplifications, the bureaucratic burden is still perceived as heavy when compared to other developing countries.

Another set of measures was aimed at strengthening anti-trust and consumer protection policies. In 1991, the anti-trust law enacted in 1962 was reinforced by new and more stringent legislation; in the same year, a Consumer Protection Law was enacted; in 1994, a new anti-trust law was passed, consolidating the legislation on competition, while establishing harsher penalties and more expeditious enforcement procedures.

Other measures focused on the elimination of legal restrictions limiting entry into several non-tradable sectors. Foremost among these were the constitutional amendments that discontinued public monopolies in oil and infrastructure and the differential treatment afforded to domestic and foreign companies. The oil sector was opened up to new entrants and a new regulatory agency was created (ANP – Agência Nacional de Petróleo). The gas sector was also opened up, after a constitutional amendment discontinued the public monopoly introduced by the 1988 Constitution. Other, infra-constitutional, distinctions, such as the restrictions imposed on the access of foreign firms to public credit, were also discontinued. The end of legal restrictions limiting entry and establishing price controls in a number of sectors, such as civil air transport, ports, interstate and international road transportation, the distribution of fuels and the distribution and transportation of steel, also encouraged competition. Nationwide price equalisation was discontinued for fuels.

The end of the high inflation era in mid1994 exposed the deficiencies of bank supervision in Brazil, and triggered a process of reform that has produced better and more stringent regulation, particularly regarding minimum capital requirements. Corporate governance law was also changed and CVM, the agency responsible for the regulation and supervision of capital markets, was restructured and strengthened, becoming more autonomous from the government.

It was in infrastructure that regulatory reform was most significant. Infrastructure regulation started to change in the early nineties, but the first critical steps were taken in 1995, when a Concessions Law was approved and the constitution amended to end public monopolies in telecom and pipeline gas distribution and discontinue the restrictions to foreign entry in some key sectors, in particular electricity generation. Together with privatisation, these sectors also experienced the dismantling of their regulatory framework, which in some cases had been in place for half a century.

Income and wealth inequality remains a big problem in the region and impedes equal access to education and hence impedes TFP growth.

In Asia, the South Korean government's aim has been to keep the degree of (monopolistic) competition high but controlled, as evidenced by a gradual lowering of entry barriers over time. The government has worked hard to maintain a competitive market environment. Although the economy is dominated by a few large firms, these firms compete fiercely among one another. Pyo shows that the government has deliberately introduced limited competition by lowering entry barriers over time and by monitoring market failures by major conglomerates in order to

maximize the efficient use of limited resources.[34] In other words, the government has played the role of competition promoter and supervisor through government-controlled banks, which are part of quasi-internal organisations. In this regard, the system has promoted monopolistic competition across industries. That is why one observes a larger number of automobile manufacturers, telecommunication equipment producers and mobile phone companies in South Korea than one normally observes in many developing countries or smaller advanced countries. For example, in automobiles there were at least three producers, and in electronics there were always more than three competitors. In the case of the semiconductor industry, Samsung entered the market in the early 1980s, following the Japanese semiconductor manufacturers. But then the South Korean government allowed market entry by Lucky-Gold Star (LG) and Hyundai to promote competition. Such an example is not limited to export industries. The monopoly of the Korean Airline Group in the airline business was broken when the government allowed the market entry of the second airline (Asiana) in the mid-1980s. In mobile telecommunication, the government tried to break the monopoly of SK in cellular phone services by issuing another license to a cellular operator called Shinsegi, and then introduced further competition by issuing licenses to three PCS service providers. The bureaucrats wanted to avoid any blame for being bribed or lobbied by a particular business conglomerate.

For the Arab region, although a competition law has been introduced in Morocco, there are still many barriers to the entry of both foreign and domestic investments. Hence, it seems that competition efforts have been undermined.

Africa: In Tanzania, with its many state-owned enterprises, privatisation has clearly led to higher TFP. It was argued that the legacy of apartheid had a strong lingering effect on productivity by creating a dual economy: one that is highly developed where firms use modern technology, and one that is characterized by high poverty, unemployment and underemployment. This situation was thought to negatively impact on TFP growth by, for example, increasing social tensions.

The difficulties and necessary preconditions for successful privatization were clearly uncovered by the country studies. There was also some evidence of how the social dimension may impact on TFP growth. None of the country studies touched upon the role of the environment.

[34] Pyo, Hak K. (2000), "Excess Competition, Moral Hazard, and Industrial Trauma in Korea (1997-1998)", in the Aftermath of the Asian Crisis, D. Dasgupta, U. Dadush and M. Uzan eds., Edward Elgar Publishing, Cheltenham, UK.

1.3.2. Lessons learned

1.3.2.1. Agreement

The importance of infrastructure featured prominently in the Review, and this was corroborated by the country studies as well. The country case studies showed how, in Brazil, due to a constrained fiscal situation, the quality of infrastructure has deteriorated and has therefore exerted a negative impact on TFP growth, while in Chile it has expanded rapidly with an ensuing positive effect. However, the Review also highlighted that it may actually be the management of infrastructure that matters the most, and not simply its existence. Financing was raised as an additional concern, where incurring debt was shown to be counterproductive. The country studies also pointed to the importance of the kind of services provided by the existing stock of infrastructure.

That physical capital is a major contributor to productivity performance goes without saying. The country studies revealed Asia, in particular, as a star performer in this respect, but raised a warning finger about whether the source of financing is domestic or foreign, since the former is less vulnerable to shocks such as the Asian financial crisis.

Box 3: Capital accumulation in South Korea

South Korea has the fastest growth rate in capital stock in our sample. The growth rate there was higher than that of Japan (10.3 %) in its high growth period (1964-1985) and that of net stock in Taiwan (1960-1987). Such a rapid accumulation of physical capital can be made possible under two conditions: One is a sustained continuation of high rates of return, and the other is a continued rise in the savings rate, in particular the private savings rate.

As observed in Pyo and Nam (1999), South Korea's before-tax gross rate of return (gross operating surplus/ gross capital stock) was as high as 33.7 % in 1971, higher than Japan's (31.2 %), which led Harberger to term the two economies "outliers". At the same time, the two economies had maintained a savings rate higher than the OECD average. Even though both Japan and South Korea experienced a rapid decline of the rate of return from 1975 and 1985 respectively, and their rates ultimately converged to the OECD average level by early 1990s, they had met these two conditions for the rapid accumulation of physical capital.

The high rates of return in South Korea during the 1970s and the 1980s were made possible by the combination of two factors. One was the relative suppression of the labour movement and wage increases and the continued incentive for internal corporate retained earnings through a low-dividend policy. The other was households' preference for higher savings and lower consumption for educational purpose and investment in housing, to guard themselves from hyper-inflation. The expansion of primary education during the late 1950s had allowed many beneficiaries of this to begin moving up the ladder of higher education; they had been taught about the virtue of savings for higher education and for securing housing. The private savings rate in 1960 was only 5 percent but more than doubled within a decade and more than tripled within two decades. The gross savings rate increased from 9.0 percent in 1960 to 18 percent in 1970, 24.4 percent in 1980, and 32.4 percent in 2000. The domestic gross investment ratio started off at 10.0 percent in 1960 but quickly increased to 36.2 percent in 1980, exceeding the gross domestic savings rate, although it fell to 28.3 percent in 2000.

The sustained productivity growth in South Korea over the four decades from 1960 was made possible by the sustained growth of gross domestic savings, particularly private domestic savings, which were channelled into sustained domestic investment. Otherwise, South Korea might have experienced the foreign debt problem that many Latin American countries went through in the 1980s.

Investment in capital in Africa has suffered due to a difficult business environment. The business climate can, therefore, explain the extent to which investment can affect productivity performance.

The review argued for financial development, while the country-case studies referred to a lack of credit as a hindrance to TFP growth. Lack of credit could also be a symptom of inefficient allocation of investment rather than actual lack of credit as such, thus underscoring the negative effects of financial repression. In Latin America the financial system is not so well developed and has, therefore, acted as a deterrent to TFP growth.

The case studies contain countries with different types of political institutions, and it seems that economic performance has been largely detached from such influence; at least this was not highlighted by the country experts as a major factor. The Review tends to agree with this finding.

The Review placed a lot of weight on economic institutions, and the country studies indicated no doubt that such institutions are key to TFP performance. The case of India showed what can be accomplished by a change towards good institutions, while in Latin America poor institutional structure was named as a serious impediment to TFP growth.

Integration or trade was argued to be important by both modes, but it is crucial to note that it is imports that matter, and not trade in general. It is difficult to disentangle the role of actual trade from trade policy (toward openness). Hence, both modes look positively on trade liberalization that increases access to foreign capital, and thus to embodied foreign technologies, and which implies a "non-destructive" increase in competition. Latin America stands out as a good example of the imports effect, in both positive and negative ways. Although South Korea has greatly underlined the significance of export-led industrialization, we do not find much other support for exporting, except for that of financing imports. There was also some evidence that integration may be a function of institutions.

It was agreed that privatization, being beneficial to TFP growth, is best undertaken gradually, while making sure that the development of a regulatory framework keeps pace with it. One particular risk to avoid is that of turning a public monopoly into a private monopoly. The purpose of privatization is also critical: The country studies (Latin America) showed cases of dubious motives leading to results that did not necessarily contribute to TFP growth. Positive effects of privatization were obtained in the case of Tanzania, where the large number of state-owned enterprises created a lot of inefficiencies. Competition was concluded to be essential to productivity, and the country-case studies proposed trade liberalization, for example, to this end.

Box 4: Privatization in Argentina

In a study of the performance of privatized non-financial enterprises, Galiani et al. (2001) found substantial increases in their profitability and operating efficiency after privatization. Productivity indicators improved because of massive layoffs,35 but also because privatized firms increased production and introduced modern management methods and production and organizational technologies. In fact, investment by these firms increased at least 350 per cent as a result of privatization, a process that was greatly facilitated not only by the easy access to the international financial market but also by trade liberalization in capital goods.

Privatizations often had highly positive impacts on the quality, availability and, to a lesser extent, the costs of the respective services and/or products. For instance, the productivity of ports improved remarkably. The Buenos Aires Port, which operated with 8,000 employees before the reforms, had only 2,500 employees in 1994. In turn, many labour regulations were abolished. This allowed substantial cost reductions.

Electricity tariffs were also reduced, especially for the large business sector, and the capacity increased from 13,267 MW to 18,100 MW five years after the privatization. In gas, transport networks increased their capacity by 60 per cent between 1992 and 2000. In turn, the gas distribution network grew 58 per cent, from 66,765 to 105,614 km. In telecommunications, the number of lines increased 100 per cent in 1989-2000. Average productivity increased from 92 lines in service per employee in 1990 to nearly 400 lines in 2000 (Gerchunoff et al, 2003).

Considering these data, how can we explain the growing unpopularity of privatization in Argentina? First, some state enterprise sales were associated with corruption, an issue that public opinion was very concerned about in the late 1990s. Second, substantial quality improvements were not attained in all cases – for instance, passenger railway services did not improve significantly after privatization. Third, while the business sector benefited most from tariffs reductions, households suffered tariff increases in some cases, for example in basic telephone services. Fourth, privatizations resulted in massive layoffs, and hence were perceived as one of the main causes of the high unemployment levels. Fifth, no incentives were put in place to foster backward linkages with local suppliers (in fact, local supply was largely replaced with imports) nor to induce privatized firms to engage in innovation activities. Last but not least, regulatory norms and agencies were very heterogeneous and, in some cases, were not only weak or deficient but also almost non-existent. This meant that the notable productivity increases attained in most privatized activities were not fully transferred to consumers, hence limiting the social benefits generated by privatization.

Despite there being little evidence, it was suggested by both modes that social inequality might be a deterrent to TFP growth, especially by creating political instability that reduces vital investments in human and physical capital.

1.3.2.2. Disagreement

Although there was some evidence that the 'old-fashioned' type of structural change (i.e. agriculture to manufacturing) was important for South Korea and China, it was argued in the

[35] Employment in former state enterprises decreased approximately 40 per cent after privatization. YPF, for instance, reduced its personnel from 36,935 to 9,350 employees.

Review that this was of relatively minor significance. Obstacles to turnover dynamics, i.e., the ability of the economy to let firms enter the market, were seen as more central.

1.3.2.3 Synthesis

We have contrasted the results of TFP determinants from two modes of analysis. The first one was based on regression analysis of large sets of countries, industrialized and developing, while the second one collected evidence on 15 selected country cases. Both analyses shared the same framework in terms of chosen determinants, but it was our hope that cross-country heterogeneity hidden in regression analysis would be unveiled by the country studies. In several cases this materialized.

In general, both modes of analysis strongly agreed on the most important TFP determinants, although they attached dissimilar weights to different variables. There was complete agreement about determinants such as human capital (education and training); physical capital including infrastructure; financial development; technology transfer and absorptive capacity regarding knowledge creation; privatization and trade liberalization to achieve increased competition; and economic institutions.

There were diverging views about structural change, where the country studies suggested that the agriculture-to-manufacturing shift is important for TFP growth, while the cross-country regression evidence for this turned out to be weak. The country studies also placed little emphasis on health (AIDS in Africa being an exception) and geography (again the two exceptions were found in Africa), two determinants for which empirical evidence was found to be strong but that were of minor concern in our sample of countries.

Was there any significant cross-country heterogeneity to report? The fiscal situation is a determinant of infrastructure investment, as highlighted in the case of Brazil. Therefore, a simple regression between TFP growth and infrastructure may only scratch the surface, without showing the "real" underlying factors.

Although investment in physical capital is, without doubt, important for productivity performance, it is likely to be sub-optimal unless the financial system is sufficiently developed to allocate funds efficiently to the most profitable projects. Hence, although high capital accumulation can also be had with a poor financial system, it will not be as productive as that obtained with a well-functioning financial system. In addition, the business environment in general seems to be a factor in the willingness to undertake investment. How this somewhat subtle feature of capital deepening can be accounted for in regression analysis appears rather challenging.

It seems clear that many of the strange results obtained in TFP growth-trade regressions, or probably also GDP growth-trade, may be due to an improper understanding of how trade actually impacts on productivity performance. First of all, it seems that TFP growth is best

regressed on imports and, perhaps even better, on imports of machinery and equipment. The reason for this is that foreign capital tends to embody relatively advanced technology. Second, another role of imports is to increase the degree of competition, and this message is clearly delivered by the country studies. When regression analysis is attempting to learn about the effects of imports, competition should, therefore, be taken into account. Third, one should not confuse trade policy with actual trade. Insofar as trade opportunities created by, for example, trade liberalization are immediately and completely reaped, these are likely to be the same thing. As this is unlikely to be the case, our findings suggest these concepts would be better analyzed separately. Fourth, the country studies show that trade liberalization can cut both ways, depending on the economic conditions in which the policy is implemented. Finally, it seems that integration (and trade) is a function of institutions!

In conclusion, it seems to us that both modes of analysis are valuable although they ask somewhat different questions. Regression analysis more or less sketches an average picture without saying much about the conditions under which determinants can be expected to influence TFP growth. Such general information is, without doubt, indispensable but, for a policymaker interested in his particular country, a sketch will not be good enough. Country studies, therefore, in presenting a painting with all its fine details, provide a very valuable complement to the general picture of the world. It is, however, our conviction that it is the combination of the two modes of analysis that offers the most useful tool for both policymakers and economic analysts.

1.4. Conclusions

Several conclusions emerge from these deliberations. First, it seems that the intuition that technology is the main source of productivity holds its ground. Theory, having resisted (up to now) several attempted refutations, allows the maintenance of the Solowian view that the "factor something" that is at work to generate TFP (e.g. growth of output in excess of growth in the inputs) is technology.

Second, given the public good character ingrained in the knowledge dimension of technology, the topic of economic policy enters the scene to take charge of the externalities that are at work. Market forces ignore the growth-enhancing potential of externalities. For instance, firms accumulate capital because it is indispensable to their production, and in doing so they do not care that capital inadvertently generates technology at the macroeconomic level. Thus, the market-geared rate of capital accumulation is inferior to the socially optimal rate. In such a case it might be useful to have policies to stimulate accumulation to the point where it becomes optimally supplied.

Third, from theoretical principles we have expectations about the outcome of policies. Policy intervention, for example, subsidies to R&D or public expenditures on public goods, are expected to increase the level of macroeconomic variables, and also to have a transitory impact on growth rates; they are not, however, expected to have a permanent impact on growth rates

(policy transiently deviates the actual growth rate from its steady-state, but, after a while, the attraction of the steady-states defeats the impact of the policy).

Fourth, policies are bound to be ineffective if the environment is not propitious. Obviously, R&D or labour skills in the absence of successful innovating firms would be a waste.[36] If there are only a handful of firms, the impact of policies will be limited. Incremental efforts in R&D or labour skills are spread over an incremental amount of products; they cannot be expected to pull the whole economy along. Furthermore, the diffusion of the fruits of these efforts requires the development of all sorts of complementary inputs, the retraining of the labour force, and the re-organization of work methods. All these factors can slow down or jeopardize productivity gains. The productivity potential depends upon the current productivity level of the country. Policies have to aim at the effective potential that can be achieved. Hence, policies will have to be modulated according to the circumstances of that country.

Fifth, given that technology – the growth of technology – is the most important source of productivity, then two broad targets appear for pro-productivity actions: R&D and human capital. These targets are not mono-dimensional. Both R&D and human capital have several dimensions that policies may address. Nor are the targets independent from each other. There is solidarity between R&D and human capital in their influence on technology. Finally, the targets are not independent from other factors. The nature of R&D and human capital, as well as the desirable size of their stock, depend on the stage of accumulation of tangible factors reached by the country.

When it comes to R&D, it is useful to differentiate innovation from the implementation of technologies innovated by others. Countries at high productivity levels will do relatively more innovation; countries at low levels will do relatively more imitation of simple existing technologies. Countries at intermediate levels will do more implementation of intermediate technologies. Clearly, policies will have to take into account the various facets of the technological effort. There will have to be policies for innovation, for implementation, and for imitation.

Sixth, the extent to which achievements in the proximate determinants – the sails -- will be translated into effective productivity performance depends upon more distant determinants – the rigging. The rigging, too, must be in tune with the circumstances of the country being considered. Imitation, for instance, requires a different rigging than innovation.

Seventh, given that countries are supposed to have a potential defined by their level of development, it would be interesting to identify where the potential corresponding to the various levels of development of individual countries lies. Is the potential of countries at low levels of productivity just a little bit different from that of other countries, or is it quite different? Does

[36] See Benassy, J.P., "Is there always too little research in endogenous growth with expanding product variety?" European Economic Review, Vol. 42, No 1, 1998, pp. 61-69, for a case where research can be sub-optimally high.

that potential change through time, and, if so, in which direction and to what extent? All these questions are tremendously important in gaining an understanding of the size and time dimensions in which policy efforts have to be framed; it will be the role of the next chapter to try to shed some light on these questions.

Chapter 2 The global picture

Introduction

In the previous chapter it has been assumed, as a hypothetical framework, that productivity increases as countries tap an unfolding set of technological possibilities. The countries of the world are unequal in their capability to access this set. The distribution of this capability appears to be stratified in layers defined by each country's current productivity level. These layers would not develop homothetically as the set unfolds. Thus, some categories of countries would be increasingly left behind. The layer assigned to a country depends on the stage of development of that country, which itself results principally from past accumulation. Within a given layer, the potential of a country to grab the related technological possibilities depends on its R&D and human capital and on the efficiency with which it makes use of its potential.

This chapter picks up the task of giving these hypotheses an evidence-based representation. To do that, a model and data are needed. The data come from an ad hoc database developed by UNIDO that can be consulted on line on UNIDO's web site. This model will now be presented. Further sections of this chapter will present the results and discussions of the findings.

2.1. The aggregation framework[37]

2.1.1.The notion of technology

Technology is knowledge about available techniques. From the point of view of economic analysis, a technique is fundamentally a combination of factors (for instance, a man with a bulldozer and a man with a shovel are two techniques). Worldwide technology is, then, the set of all the combinations of factors used worldwide to produce goods and services. The development of technology means that new techniques accrue to the set. These new techniques replace less efficient incumbents of the set. The new techniques allow the production of more per bundle of inputs (or they need less inputs to produce a unit of output). This gain – or saving – is the productivity gain resulting from the technological change.

It goes without saying that such an immense set must be represented in a drastically simplified manner to become operational in economic thinking. In this book two simplifying assumptions are made. First, only two factors are used in production, namely capital and labour. Accordingly, a technique is characterized in terms of capital intensity, which is itself defined as the quantity of capital used by one unit of labour (this parameter is called the capital/labour ratio). More advanced techniques are assumed to be more capital-intensive techniques. Second,

[37] See Isaksson, A., "Understanding Productivity" and "Measuring Productivity", 2005, for treatment of concept and measurement issues.

it is assumed that the multifarious techniques in use in a country can be represented by a single capital/labour ratio.

In our definition, countries with higher capital intensity are said to have more advanced technologies. Hence, technology growth occurs when the capital/labour ratio of an economy is on the increase. Given that definition, it is clear that access to more advanced techniques needs the accumulation of capital that allows the quantity of capital per unit of labour to be incremented.

It is useful to distinguish the channels of technological change. On the one hand, technology may grow because innovation takes place: Techniques more intensive in capital are introduced into the economy. On the other hand, the ratio may change because the structure of production changes in a direction that gives more room to existing high intensive capital techniques at the expense of less capital-intensive techniques (re-structuring).

2.1.2. The notion of a worldwide technological frontier

A given technique does not necessarily produce the same amount of output in all countries. At a given moment in time a certain technique will be capable of producing a maximum level of output.[38] This maximum is the best practice observed among all the countries possessing that technique. The worldwide technological frontier is a benchmark frontier comprised of the best practices observable for all the techniques used in the world (represented by our sample). The borderline is drawn as the highest output achieved per bundle of inputs at a given moment of time. The bundles of inputs are arranged in order of increasing capital intensity.

2.1.3. The notion of efficiency

The performance of a country is gauged by its actual output produced compared to the maximum output its technique is capable of producing. This maximum is indicated on the technology frontier. The country's performance is measured in relation to the point of the borderline that is closest to its position, i.e., with the best performer who shares the same or the closest capital/labour ratio. A country located on the frontier is a top performer; countries behind the frontier go down the performance scale the further they are from the frontier. Thus the benchmark frontier is made of the efficient users of the respective techniques considered (i.e. no other country produces more output with the given combination of capital and labour). The benchmark frontier represents the potential technology level common to all countries that have arrived at a given stage of development.

[38] This maximum may grow through time. For instance, it may grow by learning-by-doing.

The efficiency of the country is its degree of utilization of the potential technology level. Any country located within the border produces less than appears possible with the given combination of capital and labour and is therefore said to be technically inefficient.

2.1.4. The difference between productivity and efficiency

Countries with more advanced technologies tend to have higher labour productivity. But it is important to note that, contrary to what is often thought, higher labour productivity is not necessarily synonymous with higher efficiency. For instance, a country at a lower level of technology that uses its techniques to the full potential is reputed to be more efficient than one that employs more advanced techniques but does not make the best use of them. Efficiency only refers to the performance given a potential. Productivity is a vector combining the dimension of productivity potential and the dimension of utilization of this potential.

2.1.5. Two drivers of productivity

As mentioned earlier, it is possible to construct individual productivity performance as the distance of a country from the worldwide best practice pertinent to the technological level of the country. Measuring this distance at different points of time, it is possible to ascribe the changes in productivity performance to two multiplicative factors: shifts of the worldwide technological frontier, and changes in the distances between individual countries and the frontier.

The frontier shift

The frontier shifts either because better techniques are brought into existence, because existing techniques are brought to new records of productivity, or because less sophisticated techniques are discarded.

It is noteworthy that a shift not only marks a change in the actual performance of the country that made the breakthrough but also in the potential performance of all other countries using the technique that recorded the productivity gain. In principle, the best practice can be transferred internationally. Hence, when the best practice changes, the productivity potential of all countries changes too.

For the sake of clarity, it may be useful to distinguish three kinds of innovation: *radical innovation*, *adaptation* and *imitation*, where only the first one is innovation in the strict meaning while the latter two are the result of technology diffusion and appear as innovations to the recipient countries. In practice these three innovations often take place in an interrelated manner. *Radical innovation* is the generation of new-to-the-world techniques. Radical innovation is sourced in inventions that are generated by technological creativity. This creativity comes from coupling a strong R&D sector, with ties to industry, commerce and services, to a

strong basic scientific research capacity, complete with universities, modern laboratories, public finance support, government agencies, and civil societies such as scientific academies. Of course, to build up and maintain these assets, heavy technological investments and expenditures are needed. To cover the costs of the innovation system and the risks inherent to innovation, the market structure must authorize profit margins. The key to these margins is productive flexibility and product differentiation.

There is a kind of technological change that relies on *adaptation*. Well-established techniques are incorporated in the production system after modifications to fit the commercial and technical needs of the host environment. The adjustment to local circumstances requires the existence of a technological system comprised of scientists, engineers, technicians and managers specialized in the D side of R&D. It also demands support institutions and an open economy.

Imitation is the straightforward incorporation of techniques used by others. Imitation presents little risk since the techniques can be observed in operation before incorporation in the host environment. The requirement that imitation places on the recipient is to possess a productive system large enough to allow specialization and stable enough to ensure experience. Imitation demands little in the way of a country's own technological assets since the techniques come from abroad. It requires, however, institutions that guarantee the cultivation of long-term relationships between the suppliers of these techniques, the financiers that made their acquisition possible, and the managers that operate them.

Although the three kinds of innovation will be active simultaneously in just about any economy, their relative contributions change in the direction of less imitation and more innovation as the economy is more technologically advanced. Numerous pieces of evidence, including one by UNIDO,[39] have documented that, when innovation takes on more and more importance, the economy's requirements of skills and technological assets inflate incommensurably with the previous regimes of imitation and adaptation.

The distance from the frontier

The second factor, the distance between a country and the worldwide benchmark, is a measure of the efficiency of the country. Changes in this distance may then be interpreted as catching up, when the distance is shortened, or lagging behind, when the distance increases. Efficiency may shift without any movement on the part of the country in the sphere of techniques and productivities. It is enough that the world frontier shifts for an immobile country to lose efficiency.

[39] Machin, S., "Technology and Skills in Industry, The International Evidence", in UNIDO, Industry for Growth in the New Millennium, E.OO.II.B.3, 2000, pp.77-84.

2.2. Findings and conjectures

The above conceptual apparatus is not directed at measuring productivity in absolute terms. It focuses on comparative terms: productivity compared at different times and productivity compared across countries.

Looking at the techniques in use in the sample countries at different points of time, it is possible to draw the successive benchmark frontiers for the selected years. This section will principally present the findings obtained in watching the shift of the world technological frontier between 1960 and 2000. Before that, the TFP rankings of our 112 countries' universe will be presented at the interval dates.

The findings will be assessed in the form of conjectures. An important role in this assessment falls to the decomposition of output growth into the contributions from capital deepening and from TFP change, and of TFP into technical change (innovation) and efficiency change (catching up).

2.2.1. Findings

In Search of the Most Productive Country

TFP outcomes can be calculated at country level for any year. Countries can then be ranked in terms of their TFP performance. Tables 1a and 1b do just that. In the tables, TFP (adjusted for purchasing power parity) is normalized by the result found for the USA.

Table 1a compares the TFP rankings of 112 countries in 1960 and in 2000. In 1960 the leader was the U.S.A., with New Zealand ranked second and Switzerland third. Venezuela was among the top 10, in the company of Equatorial Guinea. As expected, industrialized countries dominated the top half of the picture. By the year 2000 Luxembourg has replaced the U.S.A. as the most productive country in the world. Ireland is the most spectacular runner up. One important finding is that, although there is some indication of convergence, it occurs only at the top half of the table. In the bottom half we see clear signs of divergence, and it appears that a bipolar situation has developed during the four decades.

Table 1b summarizes the main relative movements. The best performers are once again Luxembourg, Taiwan, Ireland and Hong Kong, but several other countries have improved immensely in relation to their initial positions. Among the latter, three African countries, Mauritius and Botswana, as well as oil-rich Gabon, are noticeable. Some countries that have undoubtedly grown fast in the past 20 years or so, most notably China and India, have not caught up much in TFP, probably because their growth is explained mainly by factor accumulation and not by productivity growth.

The World Technology Frontier in 1960 and 2000

In this section the World Technology Frontier is exhibited with the help of a few graphs. Figure 1a shows the location of all 112 countries relative to the World Technology Frontier in 1960. In that year, the maximum height of the frontier is about 32,000 dollars per worker (1996 purchasing power parity), while the maximum capital per worker is almost 54,000 dollars.
The main cloud of country points are located near the origin at low capital intensity and low output per worker. Clearly, higher capital intensity means higher output per worker, although it seems that the U.S.A. is able to produce almost as much output as Switzerland at much lower capital per worker. Table 3 shows that the average distance to the technology frontier for the world as a whole was 0.56, which means that the average country produces only at 56 percent of its potential.

Figures 1b, 1c, and 1d present close-ups of three sub-groups, namely Industrialized Countries,[40] a group we call Dynamic Developers[41] (in principle fast-growers), and Least Developed Countries[42] (LDCs).

Figure 1b shows the location of the Industrialized Countries in 1960: Most of these were already located in the northeast of the figure, but there were five exceptions, Japan, Ireland, Greece, Portugal and Spain, which were then nested in the south-west. On average, this group of countries performed well in terms of efficiency, with an average score of 0.75.

In 1960 the Dynamic Developers (Figure 1c) tended to be fairly close to the origin, with Chile, Mauritius and Hong Kong being the main exceptions and well poised for future growth. The average efficiency for this group of countries was 48 per cent, this low figure indicating that considerable productivity gains were feasible by mere efficiency advances.

LDCs were located quite close to the origin (Figure 1d). With an average efficiency of 46 per cent of the maximum they were on a par with the Dynamic Developers, but this performance was achieved within the framework of fairly less sophisticated technologies.

Figures 2a-d show the frontier in 2000. Table 3 again provides information about average technical efficiency. The world average efficiency level has increased somewhat (from 0.56 to 0.58). The apparent stability of the figures hides three interesting evolutions. The performance

[40] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the U.S.A.

[41] Botswana, Chile, China, Hong Kong, India, Indonesia, Korea, Malaysia, Mauritius, the Philippines, Singapore, Taiwan and Thailand.

[42] Angola, Bangladesh, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Equatorial Guinea, Ethiopia, the Gambia, Guinea, Guinea-Bissau, Haiti, Lesotho, Madagascar, Malawi, Mauritania, Mozambique, Nepal, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Tanzania, Togo, Uganda and Zambia.

of Industrialized Countries has fallen. Compared to 3/4 of the maximum in 1960, they only achieve 2/3 in 2000. The Dynamic Developers have gone a fairly long way towards more efficiency, while the performance of the remaining developing countries, already fairly low in 1960, has fallen further. This is, of course, a rather dismaying observation. In four decades, the majority of developing countries have not managed to improve the efficiency of techniques that, for them, have practically not changed.

There are two major features to report in the combined changes of technology and efficiency. First, as can be seen in Table 2a, the initial mono cluster of countries has split into two, one cluster of relatively poor and one of relatively rich countries. Second, the average output per worker approximately doubled in 40 years, thus widening the income gap in absolute terms. In 2000 the maximum height of the frontier is nearly three times that of the height in 1960, while the maximum capital per worker is about two and half times greater. Obviously, for the majority of developing countries, where the situation has hardly changed since 1960, the goal of closing the productivity gap seems more distant than ever.

The shift of the frontier

Figure 3 shows the shift of the technology frontier by drawing the frontiers of 1960 and 2000 in the same space. The distance between the two frontiers measures the extent of technological progress. The shift of the frontier is nothing less than spectacular. One segment has not moved (the segment corresponding to the Less Developed Countries) but the top segment exhibits a counter clockwise shift that lifts top labour productivity over $100,000 by a sevenfold increase in capital per worker. So a vast new technological space has opened up, populated exclusively by the industrialized countries plus Hong Kong, Israel, South Korea, Singapore, and the Taiwan province of China. Appallingly, the other countries still occupy the technological space already charted in 1960.

An additional interesting finding is that the production relationship seems to have tilted so that the slope of the 2000 frontier is steeper than that of 1960. In other words, technological change has not been neutral regarding capital and labour; it has been labour saving. One important implication of such a tilt is that the time of diminishing marginal returns to capital is being postponed. We can conclude that capital intensity has a strong bearing on technological change.

Productivity change and its sources

We will now move from productivity levels to an analysis of productivity growth.
Figure 4a shows the (weighted) Total Factor Productivity Growth for the world as a whole. The central line going through the graph is simply a trend line. From the absence of a slope it is immediately apparent that world TFP growth has been stationary over the past 40 years. On the whole, TFP is growing at 0.5% per year. This occurs principally in developed countries, which hold most of the weight of the world. In developed countries GDP growth is not very fast;

therefore the growth of TFP appears as a relatively large contributor. Apart from the well-known productivity dips related to the oil crises and a strong ensuing recovery, TFP growth has not fluctuated widely. The post-oil-crisis recovery of productivity growth peaks at nearly 3 percent in the mid-1980s. There is a slight downward inflection apparent before the two oil crises, and this might suggest that changes in productivity growth could precipitate a major event, such as a crisis. After the recovery another downward trend appears to start, but expansion starts at the end of the 1990s.

As stated above, productivity growth can be decomposed into change in technical efficiency and technological change. Figure 4b shows the former, again for the world as a whole. Interestingly, again with the exception of the oil crises, efficiency catch-up is a strong feature until the mid-1980s. Thereafter, there is a strong downward shift of the curve, implying that the world as a whole is becoming less efficient. Fluctuations are large, with several positive peaks at the three-percent mark, while troughs reach almost to –4 percent. Actually, there is a slight negative trend over the 40-year period as a whole.

The graph on World Technological Progress (Figure 4c) appears to be the mirror image of Figure 4b, but of course it is not. Here it is shown that the strong growth of world output witnessed during the 1960s was not driven by innovation. The growth of technology was declining when the oil crisis hit. But innovation starts to recover in the immediate aftermath of the crisis and progresses very strongly from the late 1980s or the beginning of the1990s. In this acceleration, the IT-revolution must be part of the explanation

2.2.2. Conjectures

Often the moves observed at country levels are instances of productivity disasters, thus providing a plain answer to Solow's famous question: "Do cross country regressions define a meaningful surface along which countries can move back *and* forth at will?"[43] The answer is definitely, "No." The surface does not allow all the countries to move at will and certainly not forward.

That this surface, instead of being smooth, is a viscous one, invites conjectures about, or even a preliminary explanation of, the factors hindering frictionless moves. Previous UNIDO studies already evidenced some patterns of growth of TFP and some patterns of TFP diffusion across countries.[44] These earlier findings, combined with the global picture presented in this book, point to a certain number of noteworthy stylized facts.

[43] See Solow, R., "Applying Growth Theory across Countries", The World Bank Economic Review, vol.15, No2, 2001, p.283.

[44] See Forstner, H., and Isaksson, A., "Capital, Technology or Efficiency? A Comparative Assessment of Sources of Growth in Industrialized and Developing Countries", UNIDO Staff Research Series, Discussion Paper No 3, January 2002.

1. Today's global picture is that of a small group of countries, the developed ones, camping on the frontier; a small group of developing countries staying not very far away and, perhaps, converging to that frontier; and a large group of developing countries that are very distant, and even becoming increasingly distant, from that frontier. Some developing countries detach themselves from their convergence club, exceptionally, to climb into the club of developed countries, or, sporadically, to fall among the stagnant developing countries.

This view is difficult to reconcile with the notion of a technological set equally accessible by all countries. The majority of developing countries cannot begin to think of joining the upscale portion of the technological frontier, which has shifted enormously under the impulse of labour-saving investments. The developed countries could not possibly operate the labour-intensive techniques of the lower portion of the frontier because their salary levels would not allow it. Clearly, our hypothesis that the technology potential of a country is confined within limits set by its level of technological development is illustrated in the evidence just reviewed. Obviously, even among developed countries, it is difficult to assume that technology circulates without friction given that that their distance from the frontier is not insignificant and seems to be on the increase.

The basic reason for this stratification of countries is that technology is not pure knowledge but implementation of knowledge in the material world. In order to absorb technological transfer, an absorptive capacity is needed. To build up this capacity requires investment; to operate it requires expenditures. Only countries that have invested in building up an absorptive capacity and have taken care to maintain this capacity are able to implement technology developed elsewhere. This is how the group of Dynamic Developers manages to follow the developed countries, most of them at a distance, and a few actually joining them. The Dynamic Developers show that backwardness is not fatal. Their departure positions in 1960 were hardly discernible from those of the rest of developing countries, yet they had closed a big part of the gap by 2000. If they could do it, so too could others.

The difference between the laggards and those that are pushing ahead requires some more explanation than technology transfer *cum* costly absorptive capacity. Were it only a matter of expenditures on technology absorption, why indeed would the second group of developing countries so persistently stick to their totally deficient absorptive capacity at the cost of their real incomes falling abysmally behind the rest of the world? Why, for that matter, would some countries in the first group of developing countries let go and fall into the second group? Moreover, how come that, from time to time, some countries do break away from their clubs, seldom to climb, more often to fall?

Robyn, G., "Aspects of Marginalization, Growth, Industry and Trade of the Least Developed Countries", UNIDO Staff Research Series, Discussion Paper No 1, May 2001.

One reason could be random shocks. The shift of the world technological frontier exerts a continuous pressure to keep up with adaptation effort. Any accident that temporarily compels a country to seek some respite may have punishing consequences.

The break acts like an opening scissor. On the one hand, the leading edge of technology becomes more and more difficult to absorb as the world shift goes on; on the other, the absorptive capacity becomes more and more eroded as the break lasts. After years of fiscal austerity, the laboratories and the technical departments of universities are dilapidated and the professors have moved abroad; after years of recession there is practically no industry left, no more private adaptation development, no incentive to do R&D, and no engineers or technicians to implement it.

Accidents can be negative, but also positive. Leading edge R&D sends intermittent waves of opportunities round the world. These opportunities are often specific and concern particular sectors of activity. To grab one of these opportunities, a country must satisfy two requirements. First, it needs to be in a position to invest (say, because demographic factors allow it to have a high savings rate, or thanks to a windfall of foreign resources). Second, it must be active in the sector where the opportunity is offered (what is the good of a microprocessor-based breakthrough in continuous processes to countries where there are no glass or steel industries to make use of it?). Meeting both conditions is not always possible. But the window of opportunity will be brief. This is one of the reasons why many countries do not make it.

Accidents, however, do not explain all the cases of downfall (for instance, accidents do not explain the spectacular downfall of Argentina from developed to first group of developing countries) and cannot explain the cases of upgrading from second to first developing group, like Singapore, or from the developing to the developed group like Japan and South Korea.

When the cause is not accidental, then it is perhaps in the area of policy, in the broad sense of the sails and rigging that allow the capture of the wind, that one must search for an explanation. This is the subject of the next chapters, but from the facts presented here one may already anticipate that the development agenda that will make a difference will have to marry the opposite attributes of flexibility and continuity.

A good development agenda can, it seems, detach a country from its sphere of attraction and propel it along a fast learning curve. Japan, South Korea, Singapore, Chile, Ireland, Finland appear to be witnesses to this. In these countries investors and/or governments took a strategic stance to foster technological progress, to form an alliance with a sense of purpose that lasted over decades. But the agenda was far from rigid. From the imitation to the innovation stages, policies and institutional setting were swiftly tailored so as to respond to the particular necessities of the technological ladder.

2. The most advanced countries – those on the border and, principally among them, those on the technologically most advanced segment of the border – make more TFP gains than the other countries (as if generating knowledge is easier than absorbing it). In developed countries TFP is more important for growth than it is in developing countries. The innovator of a radically new technology cannot, by definition, be inefficient in that technology since there is nobody around to do better. Being almost fully efficient already, these countries rely almost entirely on innovation to enhance their productivity.

   The potential for innovation seems to be greater at the high end of the technological scale, where techniques are very capital intensive. This seems to mean that on the top of the scale there are more incentives and more technical opportunities to break through the world technological frontier. If so, being developed appears to confer a comparative advantage in the field of innovation. Indeed, the technological space seems sticky. The absolute level of technological progress has been greater at higher income levels, thus providing one possible explanation for the aforementioned divergence between rich and poor (or the emergence of convergence clubs).[45] This is no great wonder, since the factors behind technological progress generally require resources. One could interpret this as supporting the predictions of endogenous growth models, where technological change is made endogenous and is explained by, among other things, research and development, something which takes place in relatively rich countries.

3. Within developed countries efficiency tended to decrease during the period. Two possible causes are the TFP losses in the aftermath of the oil crises and the very concentrated IT surge that isolated most developed countries behind the technological leader.

   Another explanation might be found in the circularity of the link technology-productivity-technology. A technology wave raises input, which in turn calls for a new technology wave. Suppose that technological progress leads to an output (or demand) increase, which in turn increases investment (i.e. investment is a function of output). The capital per worker ratio increases. The high tide of new techniques and the related sets of new inputs impose massive re-organizations of the whole productive apparatus. There is again a period of learning and adaptation, with a negative change in technical efficiency.

4. Technological change is not reserved to developed countries. It also concerns developing countries since industries that are now standard in developing countries also can and do undergo technological change. It is true that, where industries are at the mature stage of their lifecycle, technological change advances more through imitation or adaptation of techniques that already exist elsewhere. Yet, possibilities of radical

[45] See Quah, D., "Empirics for Growth and Distribution: Stratification, Polarization, and Convergence Clubs", Journal of Economic Growth, 2(1), 1997, pp. 27-59.

innovation exist (a glaring example is the mini mill innovation in the iron and steel industry), but their scope is more limited.

The fact that radical innovation is also possible at intermediate technological levels sheds a light on South-South interactions. Consider that a shift of some segment of the borderline of best practices increases the inefficiency of all countries that are behind the pertinent segment of the line (the borderline becomes more distant from them).
A shift of the segment where highly capital-intensive techniques are located does not increase the inefficiency of developing countries. But when a shift occurs at an intermediate technological level, it concerns, directly and principally, the developing countries. In the 80s, for instance, Latin America lost ground on the efficiency level. This was largely due to endogenous reasons, but exogenous ones, too, played a role.

Technological change occurred in Asia and OECD countries in techniques that were also in use in Latin America (the automotive industry, for instance). This can be seen in the following evolutions. In Latin America, capital and labour grew at approximately the same pace, thus the capital/labour ratio did not change. A stable capital/ labour ratio means that there was no technological change. In the two other regions the growth of capital was about four times faster than the growth of labour. The steep capital deepening that resulted indicates that the two other regions made productivity gains by way of introducing techniques that were new to them (adopted or adapted from techniques existing elsewhere, in the case of the Asia region, or innovated, in the case of the OECD). This technological boom caused, ipso facto, an erosion of efficiency in the Latin American region. The region did realize some productivity gains within the spectrum of incumbent techniques, but these gains could not match the shift of the worldwide technological frontier, with a resulting net loss of efficiency.

5. The countries behind the border tend to gain more productivity by moving towards the border (progressing within a given technology) rather than by shifting towards more advanced technologies. This case suggests that learning-by-doing is easier than adopting a new technique. It also suggests that the attraction effect of innovation at the border will not be felt evenly by behind-the-border countries; instead, it will be more powerful in countries in the technological neighbourhood of the innovative segment. Knowledge would then seem to be technology-specific. As technological innovation is more intense among advanced technologies, it follows that less advanced countries do not benefit much from world technological progress.

6. In developing countries, efficiency appears negatively correlated to technical change. This correlation is by no means intuitive, and research is on course to find an explanation. At this stage one may conjecture that it has to do with the adoption of techniques that are new to the host environment but mature in the original environment. When developing countries make technological progress, it is mostly by way of adopting techniques already in use in developed countries. In developed countries learning-by-doing had brought the industries released to the developing countries to

maximum productivity. In developing countries, the adoption of these technologies is only the beginning of the learning curve. Therefore, the transfer of the technique means, ipso facto, regress in efficiency.

7. Countries that cannot innovate or imitate, stagnate in the inefficient use of unchanging technology. These countries seem to be too far away from the border to benefit from any demonstration effect. Compared to 1960, the distribution of countries in 2000 has assumed a much more bipolar shape, suggesting divergence in income per worker.[46] In addition, the World Technology Frontier had moved outwards in a non-neutral fashion, which means that innovation basically occurs at high levels of capital intensity (it also implies that diminishing returns can be eluded by technological progress). For all there is to be seen, the divergence will continue. If the countries lagging behind are to escape from falling further behind, a process of brisk imitation must be set in motion. The international community must help in the transfer of much more technology than was transferred in the past forty years, and the countries lagging behind must accumulate capital in order to, as Abramowitz (1986) has pointed out,[47] increase social and technological capabilities.

2.3. Conclusions

The description of TFP level, of the World Technology Frontier, and of the divergence among countries has led to the conjecture that policies are needed to bring about a truly globalized world. Policies will be discussed in the last chapters of this book, but it is already clear that it will have to be policies tailored with respect to the distance between the different countries and the World Technology Frontier.

[46] A result also obtained by Kumar, S., and Russell, R., "Technological Change, Technological Catch-up and Capital Deepening: Relative Contributions to Growth and Convergence", American Economic Review, 2002, vol. 92, pp. 527-549.

[47] See Abramowitz, M., "Catching Up, Forging Ahead, and Falling Behind", Journal of Economic History, vol. 46, 1986, pp. 385-406.

Table 1a: Ranking of countries by Total Factor Productivity, 1960 and 2000

Ranking	Country	1960	Country	2000
1	United States of America	100	Luxembourg	139
2	New Zealand	92	Ireland	112
3	Switzerland	90	United States of America	100
4	Canada	87	Belgium	86
5	Denmark	80	Hong Kong SAR of China	83
6	United Kingdom	79	Netherlands	83
7	Australia	79	Italy	83
8	Venezuela	78	Canada	83
9	Equatorial Guinea	78	Taiwan, Province of China	83
10	Luxembourg	76	Australia	82
11	Netherlands	75	Barbados	82
12	Sweden	74	Mauritius	80
13	El Salvador	69	United Kingdom	79
14	Trinidad and Tobago	69	Norway	78
15	Belgium	66	Austria	78
16	France	66	Denmark	77
17	Iceland	65	France	77
18	Argentina	64	Finland	77
19	Ireland	63	Sweden	76
20	Seychelles	62	Singapore	74
21	South Africa	61	Iceland	74
22	Norway	61	Cyprus	73
23	Costa Rica	60	Spain	73
24	Jordan	60	Switzerland	70
25	Austria	59	New Zealand	69
26	Italy	57	Israel	67
27	Finland	57	Trinidad and Tobago	67
28	Mexico	56	Portugal	64
29	Uruguay	56	Botswana	63
30	Nicaragua	55	Greece	61
31	Sierra Leone	52	Japan	60
32	Iran, Islamic Rep. of	52	Chile	57
33	Israel	51	Argentina	57
34	Mauritius	49	Korea, Rep. of	57
35	Lesotho	49	Seychelles	56
36	Chile	48	Uruguay	55
37	Fiji	48	South Africa	54
38	Spain	48	Malaysia	53
39	Greece	46	Gabon	52
40	Namibia	46	Dominican Rep.	50
41	Guatemala	45	Mexico	49
42	Comoros	44	Iran, Islamic Rep. of	49

43	Mozambique	44	Tunisia	49
44	Portugal	43	Egypt, Arab Rep.	48
45	Paraguay	43	Brazil	46
46	Malaysia	42	Syrian Arab Rep.	45
47	Egypt, Arab Rep.	41	Costa Rica	42
48	Singapore	41	Namibia	41
49	Dominican Rep.	40	Guatemala	41
50	Japan	40	Venezuela	40
51	Papua New Guinea	40	Fiji	40
52	Algeria	39	El Salvador	40
53	Botswana	39	Jordan	40
54	Panama (excl. Canal Zone)	39	Algeria	40
55	Guinea	38	Haiti	39
56	Turkey	38	Turkey	38
57	Colombia	36	Colombia	38
58	Angola	36	Panama (excl. Canal Zone)	36
59	Cameroon	36	Paraguay	35
60	Brazil	36	Cape Verde	34
61	Central African Rep.	36	Morocco	32
62	Hong Kong SAR of China	35	Sri Lanka	29
63	Honduras	35	Peru	29
64	Philippines	35	Philippines	29
65	Barbados	35	Thailand	28
66	Tunisia	35	Equatorial Guinea	28
67	Gambia, The	35	Bolivia	28
68	Syrian Arab Rep.	34	Ecuador	27
69	Bolivia	34	Guyana	27
70	Rwanda	34	Indonesia	27
71	Senegal	33	Guinea	26
72	Taiwan, Province of China	33	Cote d'Ivoire	25
73	Niger	33	India	25
74	Sri Lanka	32	Pakistan	24
75	Korea, Rep. of	32	Papua New Guinea	24
76	Madagascar	32	China	23
77	Jamaica	31	Jamaica	23
78	Cyprus	30	Cameroon	22
79	Haiti	30	Honduras	21
80	Ecuador	29	Senegal	20
81	Indonesia	29	Zimbabwe	20
82	Cote d'Ivoire	29	Uganda	19
83	Guyana	29	Comoros	19
84	Peru	29	Congo	19
85	Nigeria	28	Ghana	18
86	Gabon	28	Mozambique	18

87	Mauritania	27	Nicaragua	18
88	Togo	27	Bangladesh	17
89	Mali	27	Angola	17
90	Bangladesh	26	Mauritania	17
91	Benin	25	Madagascar	17
92	Uganda	24	Benin	16
93	Morocco	24	Gambia, The	16
94	Nepal	23	Nepal	15
95	Burkina Faso	22	Rwanda	15
96	Congo, Democratic Rep. of	20	Kenya	15
97	Pakistan	20	Central African Rep.	15
98	India	19	Mali	14
99	Chad	19	Sierra Leone	14
100	Ethiopia	19	Niger	14
101	Thailand	18	Ethiopia	14
102	Cape Verde	18	Lesotho	13
103	Burundi	16	Togo	13
104	Zambia	15	Chad	12
105	China	14	Burkina Faso	12
106	Ghana	12	Malawi	12
107	Kenya	11	Zambia	11
108	Malawi	11	Nigeria	9
109	Zimbabwe	10	Burundi	8
110	Congo	9	Guinea-Bissau	8
111	Tanzania, United Rep. of	8	Tanzania, United Rep. of	6
112	Guinea-Bissau	7	Congo, Democratic Rep. of	3

Source: Isaksson (2005).

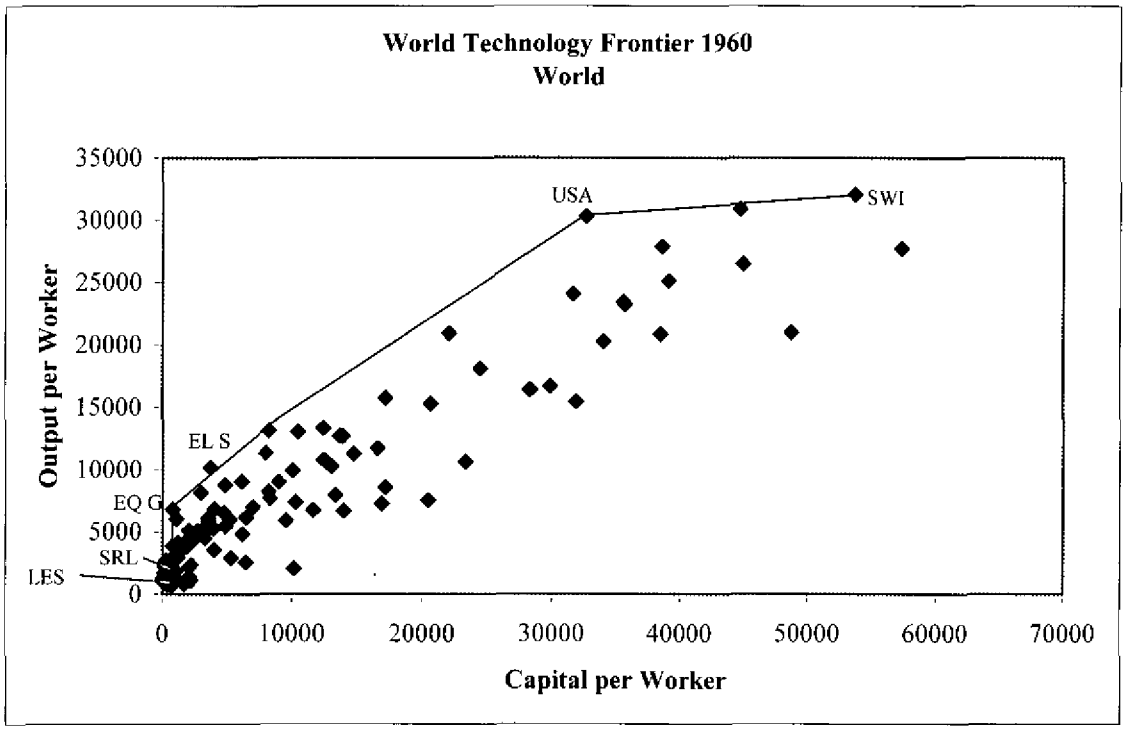
Table 1b: Catching up and falling behind relative to the U.S.A, 1960 to 2000

Catching up	Change	No change	Change	Falling behind	Change
Luxembourg	64	Australia	4	Ethiopia	-5
Taiwan, Province of China	50	Kenya	4	Uganda	-5
Ireland	49	Sweden	2	Bolivia	-6
Hong Kong SAR of China	48	Colombia	1	Seychelles	-7
Barbados	47	Guinea-Bissau	1	South Africa	-7
Cyprus	43	Algeria	1	Philippines	-7
Singapore	33	Turkey	0	Mexico	-7
Mauritius	31	Malawi	0	Chad	-7
Italy	26	United Kingdom	0	Nepal	-7
Korea, Rep. of	25	Peru	0	Paraguay	-8
Spain	25	Uruguay	0	Argentina	-8
Gabon	24	Ecuador	-2	Bangladesh	-8
Botswana	24	Trinidad and Tobago	-2	Fiji	-8
Portugal	21	Tanzania, United Rep.	-2	Burundi	-8
Belgium	20	Guyana	-2	Benin	-8
Japan	20	Indonesia	-2	Jamaica	-9
Finland	20	Panama	-3	Mauritania	-10
Austria	19	Denmark	-3	Burkina Faso	-10
Norway	18	Sri Lanka	-3	Guinea	-12
Cape Verde	16	Iran, Islamic Rep. of	-3	Mali	-13
Israel	16	Zambia	-3	Senegal	-13
Greece	15	Guatemala	-4	Cameroon	-14
Tunisia	14	Namibia	-4	Togo	-14
France	11	Canada	-4	Honduras	-14
Thailand	11	Cote d'Ivoire	-4	Madagascar	-15
Syrian Arab Rep.	11			Papua N. Guinea	-16
Malaysia	11			Congo, D.R.	-17
Brazil	10			Costa Rica	-18
China	10			Rwanda	-18
Zimbabwe	10			Niger	-19
Congo	10			Nigeria	-19
Haiti	9			Angola	-19
Dominican Rep.	9			Gambia, The	-19
Chile	9			Switzerland	-19
Iceland	9			Jordan	-20
Morocco	8			Central Afr. Rep.	-21
Netherlands	8			New Zealand	-23
Egypt, Arab Rep.	6			Comoros	-25
Ghana	6			Mozambique	-26
India	6			El Salvador	-29
Pakistan	5			Lesotho	-36
				Nicaragua	-37
				Venezuela	-38
				Sierra Leone	-38
				Equatorial Guinea	-49

Table 2. Distance to the World Technology Frontier, 1960 and 2000.

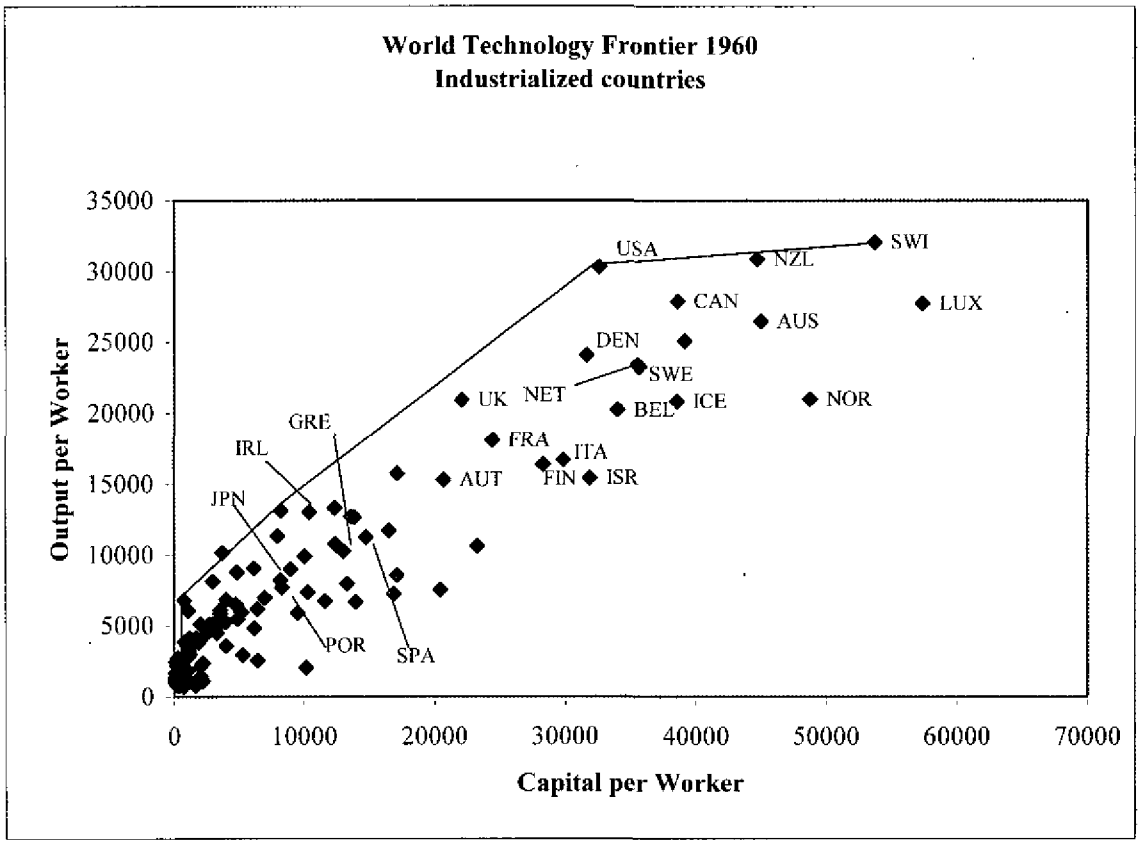
Country group	1960	2000
World	0.56	0.58
Industrialized	0.75	0.68
Dynamic developers	0.48	0.62
LDCs	0.46	0.44

Figure 1a: World Technology Frontier, 1960.



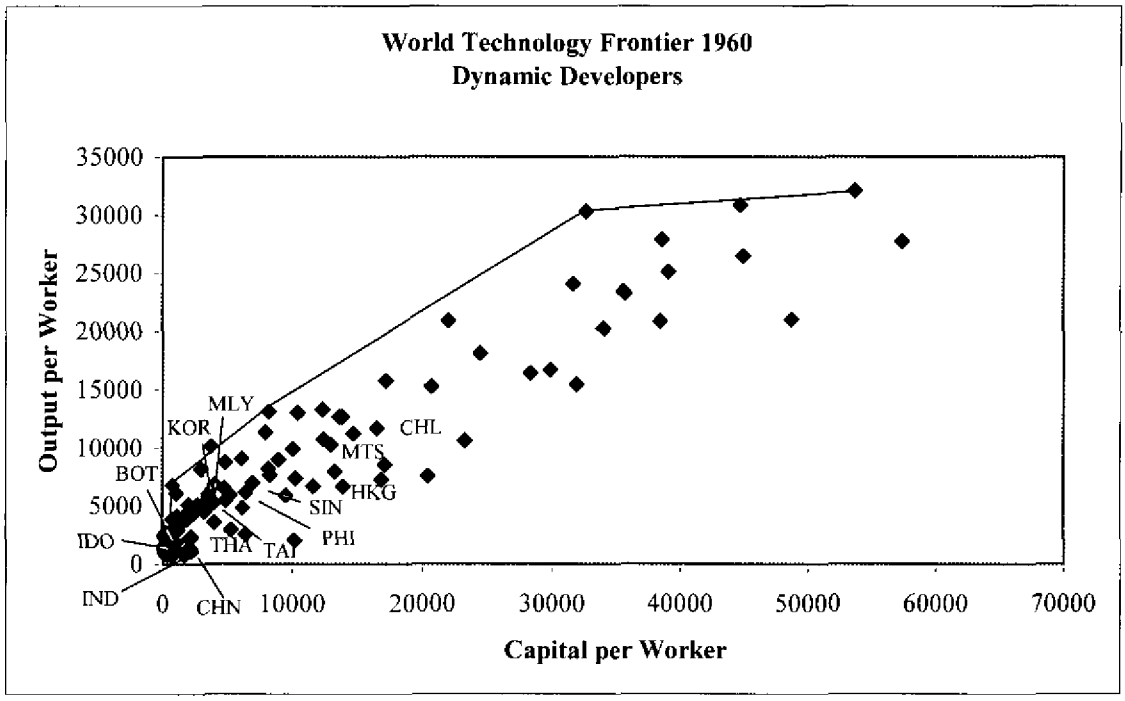
Source: Isaksson (2005), UNIDO Productivity Database version 2.0, UNIDO, Vienna.

Figure 1b: World Technology Frontier, 1960: Industrialized countries.



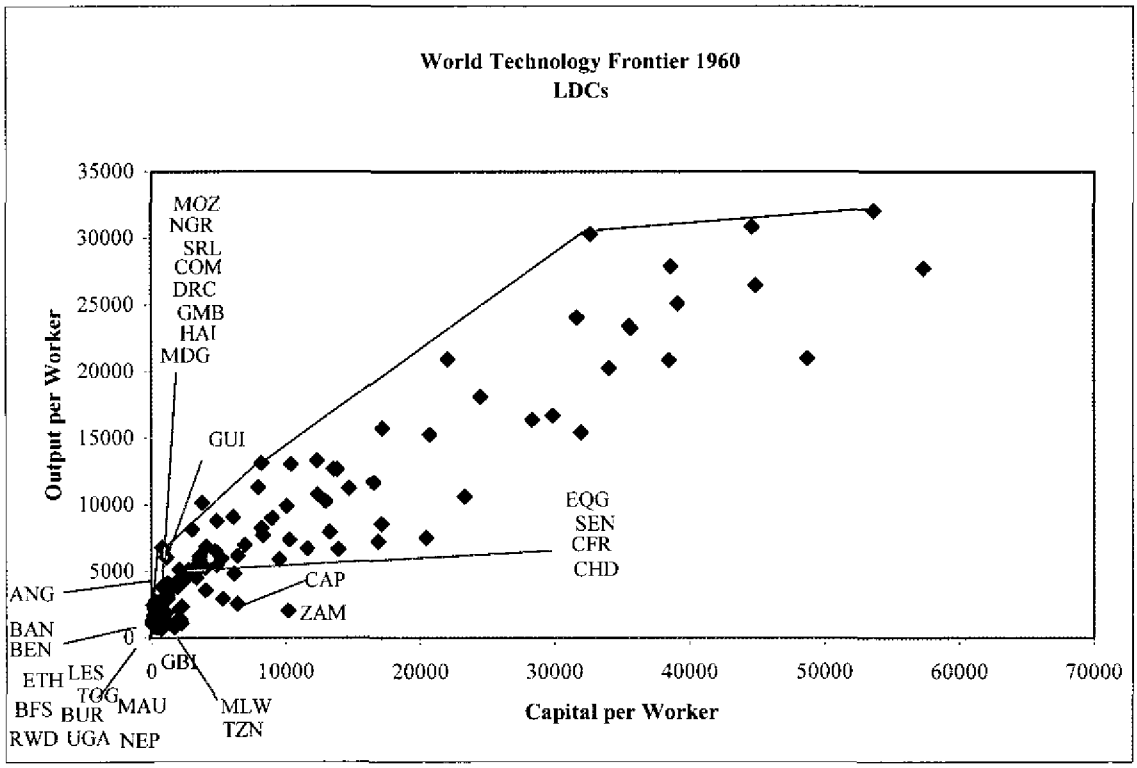
Source: Isaksson (2005), op.cit

Figure 1c: World Technology Frontier, 1960, Dynamic developers.



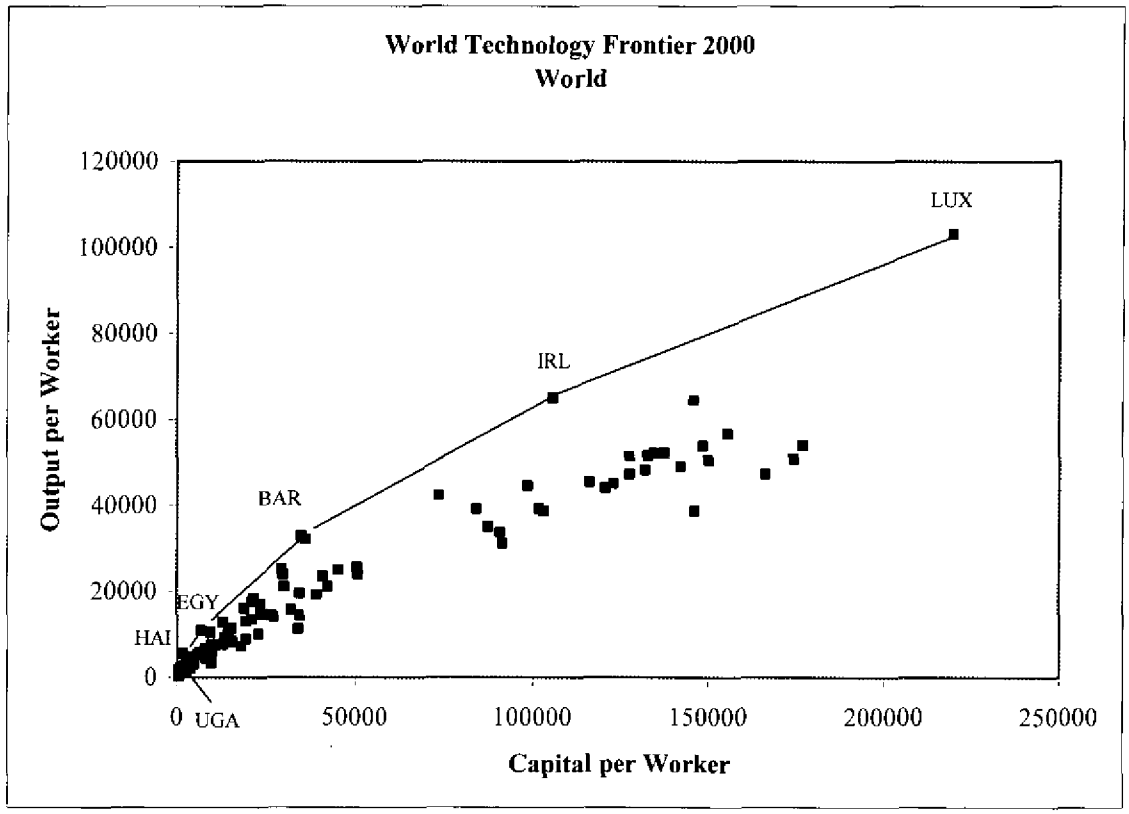
Source: Isaksson (2005), op.cit

Figure 1d: World Technology Frontier, 1960, LDCs.



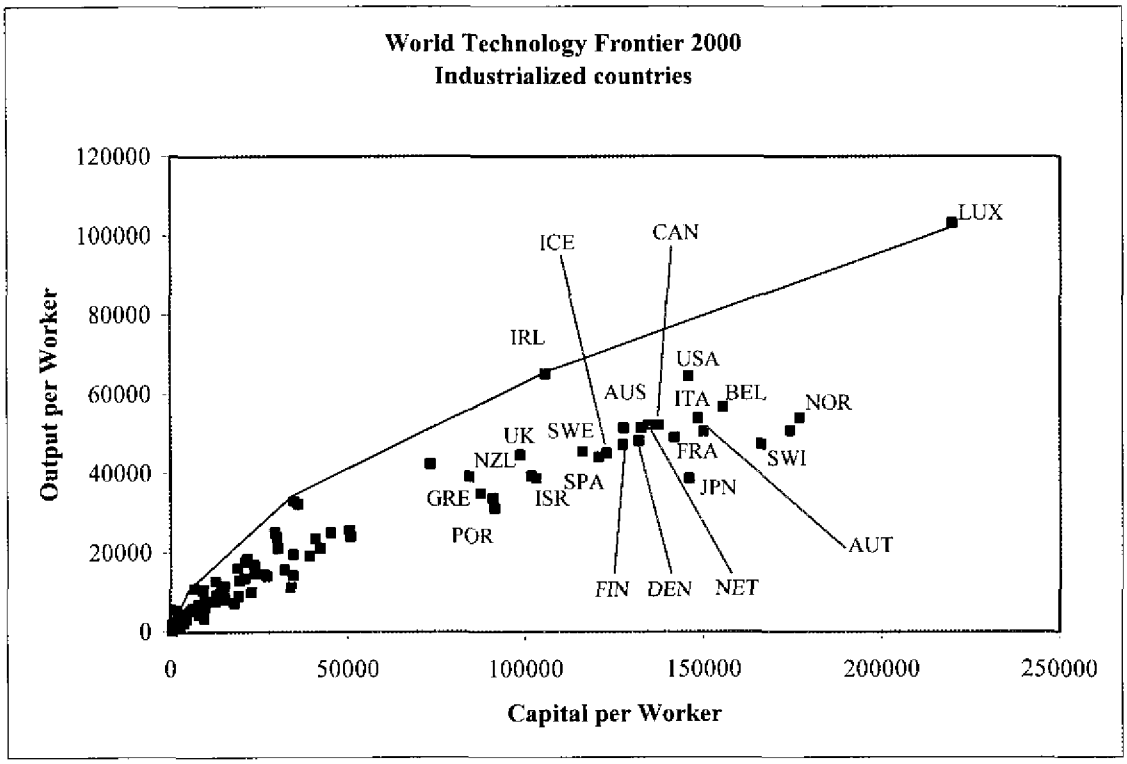
Source: Isaksson (2005), op.cit

Figure 2a. World Technology Frontier, 2000.



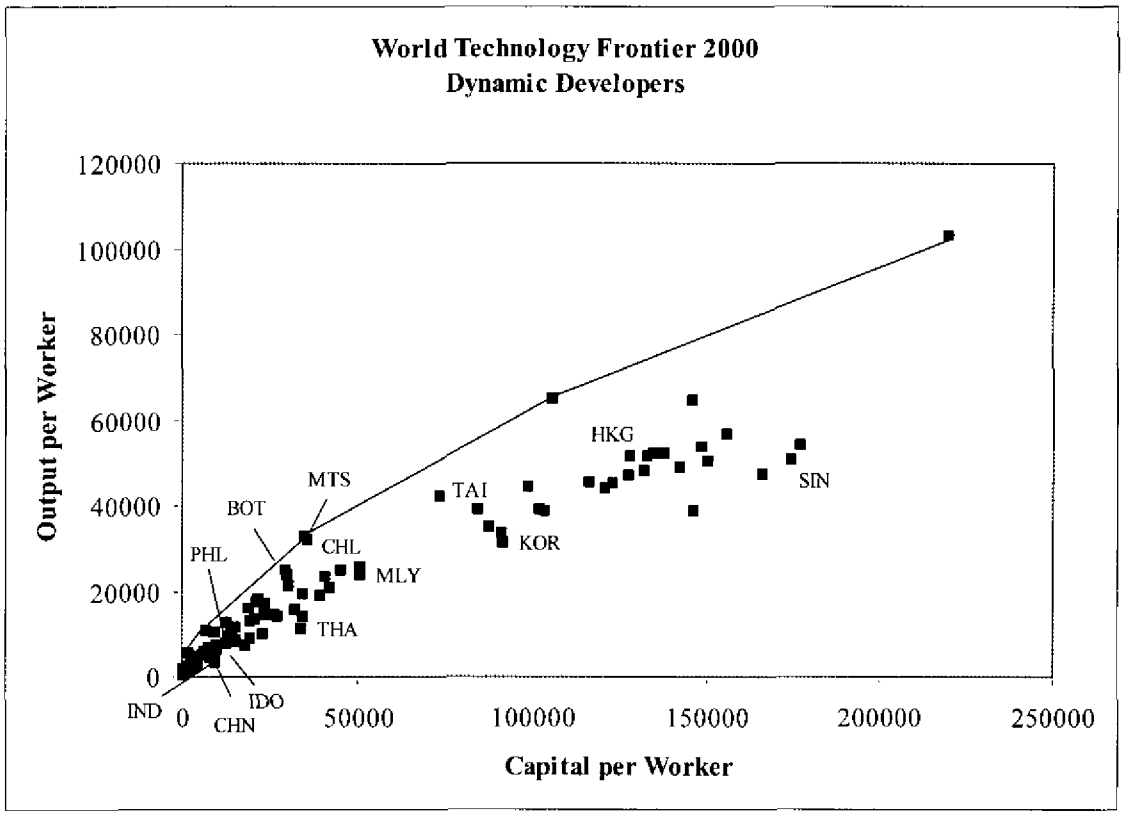
Source: Isaksson (2005), op.cit

Figure 2b: World Technology Frontier, 2000: Industrialized countries.



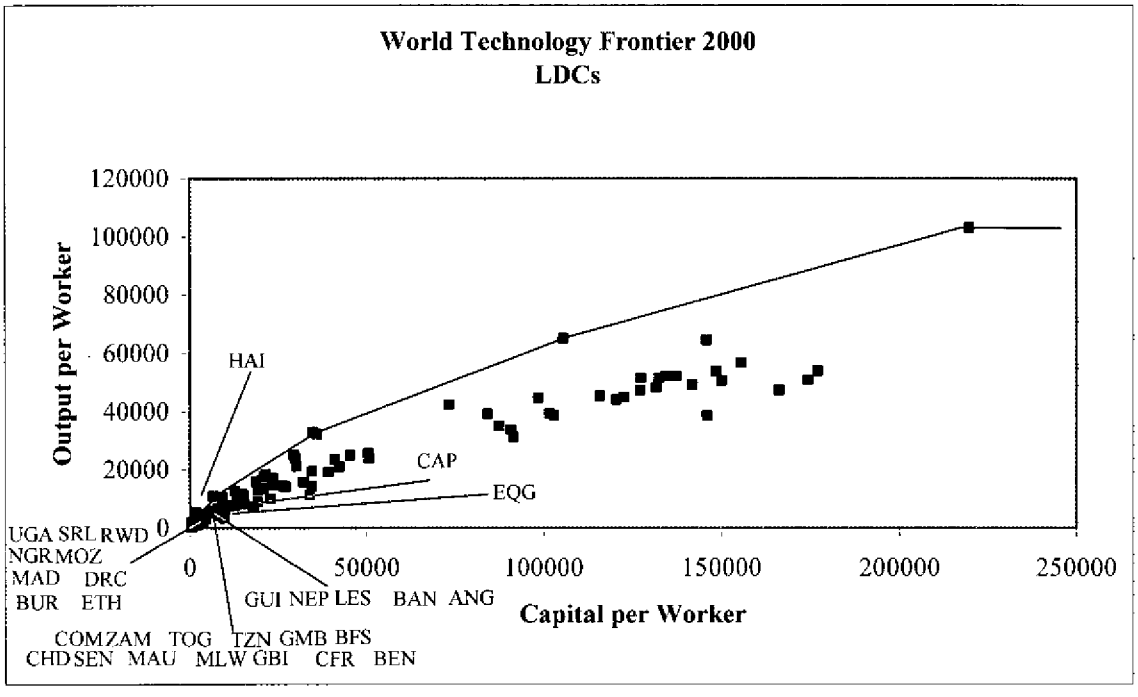
Source: Isaksson (2005), op.cit

Figure 2c: World Technology Frontier, 2000: Dynamic developers.



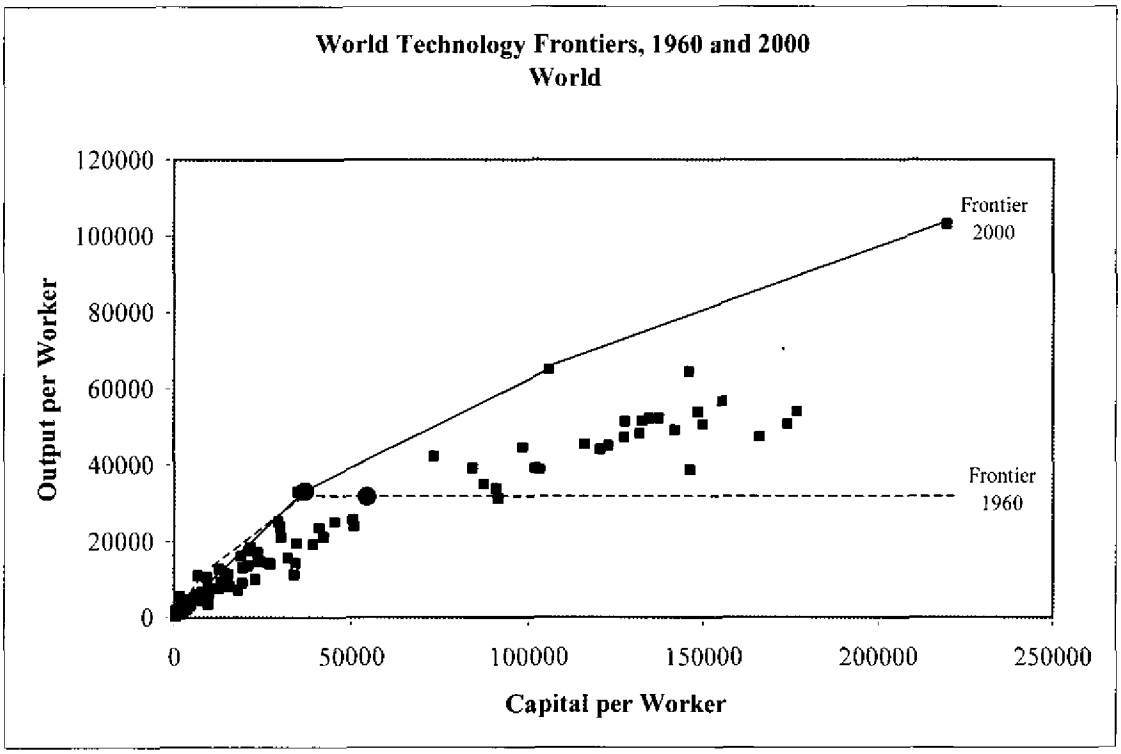
Source: Isaksson (2005), op.cit

Figure 2d. World Technology Frontier, 2000: LDCs.



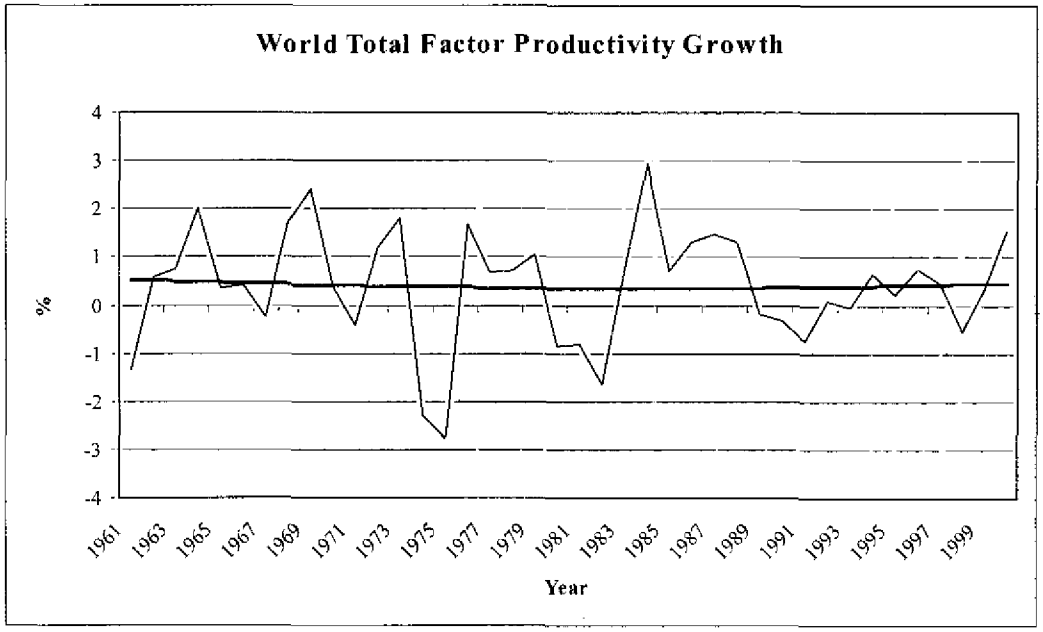
Source: Isaksson (2005) op.cit

Figure 3. World Technology Frontier, 1960 and 2000.



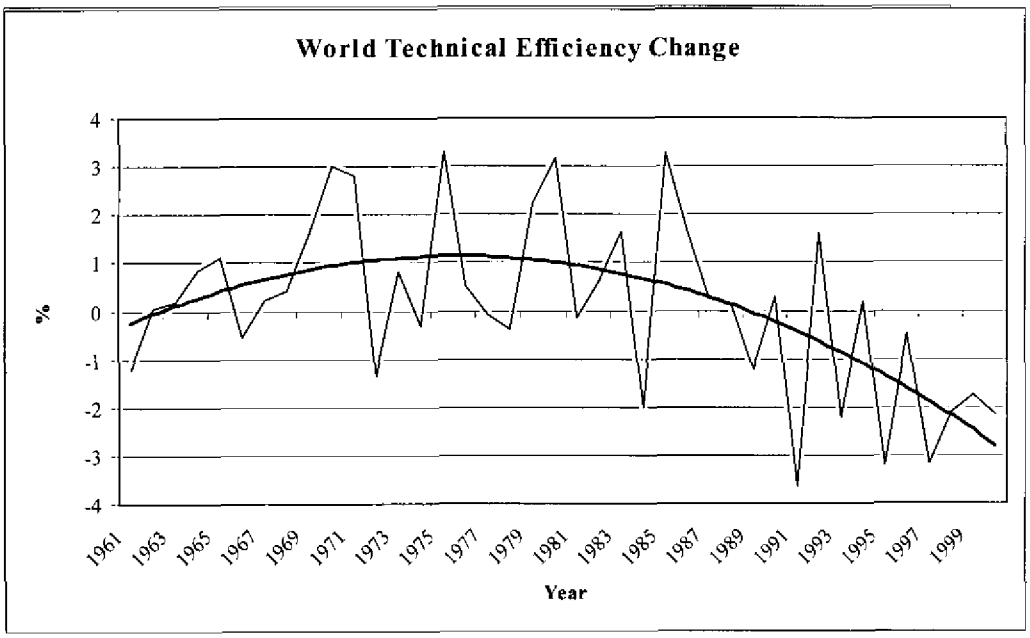
Source: Isaksson (2005), op.cit

Figure 4a: World Total Factor Productivity Growth, 1960-2000.



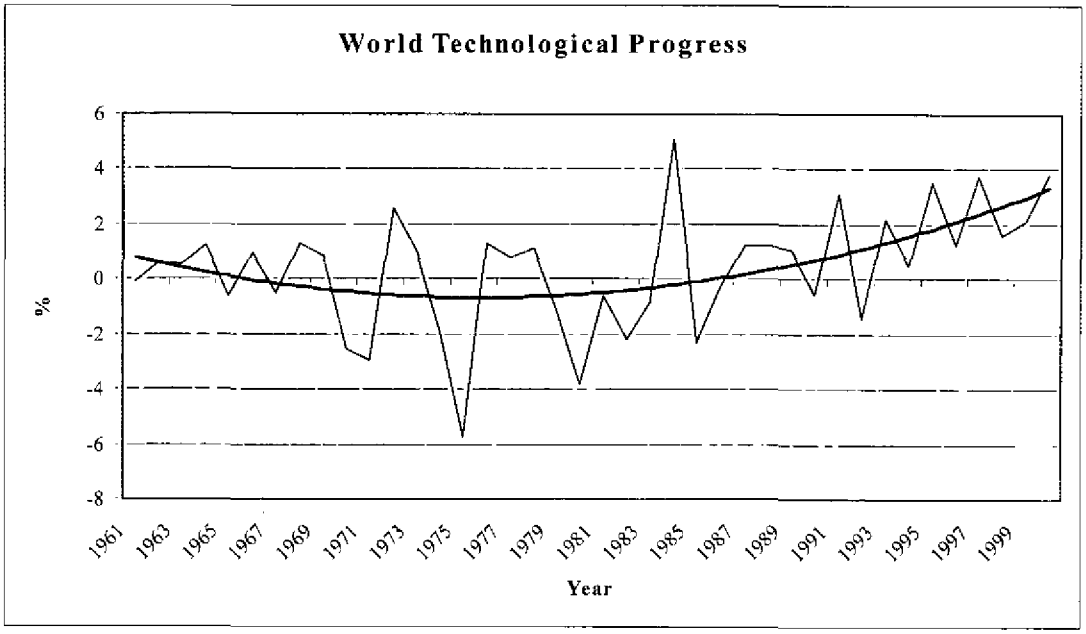
Source: Isaksson (2005),op.cit

Figure 4b: Change in World Technical Efficiency, 1960-2000.



Source: Isaksson (2005),op.cit

Figure 4c. World Technological Progress, 1960-2000.



Source: Isaksson (2005) op.cit

Chapter 3: Productivity policies with respect to the proximate determinants.

Introduction

It has been seen that the driving force of long-term growth is technology. The theoretical framework of endogenous growth explains that policies can make a difference to the growth rate of productivity. The worldwide patterns of change in technology indicate that the policy package of choice depends on the context of the country in question. The mix of innovation and imitation has to change with changes in the current level of development of the country because the relative cost of innovating and imitating changes with the country's technological development. Innovation is relatively expensive for countries at low levels of technology and relatively inexpensive for those at high levels. The drivers of innovation are the innovating firms. The policy of the government will, therefore, be a long-term policy to prepare for the entry of innovating firms. The areas of first choice for policies are the proximate determinants of technology – the sails – namely, the apparatus of technology creation and diffusion (R&D) and the qualified personnel to man this apparatus. This chapter proposes policies in these areas that will ensure that a country can profit from the wind of change without, however, overburdening its budget with sterile expenditures.

3.1. R&D policies

3.1.1. Promoting domestic technology

3.1.1.1. Why undertake domestic R&D?

Efforts are being made to improve performance but the results are generally disappointing. Is it reasonable for a poor country to do its own R&D? Three points militate in favour of domestic technology-generation, notwithstanding its relatively high cost.

- First, there is not really a trade-off between international procurement and domestic generation. Instead these channels are complementary. They are complementary as far as the commercial acquisition of technology is concerned. A prerequisite to acquiring relatively advanced knowledge is that the host country must develop its own innovative capacity. The Brazilian company Petrobras became leader in marine oil exploration thanks to the development of a new technology in association with foreign partners. The condition that permitted this association was that Petrobras already had a strong technological base and innovative culture, signalled internationally by a patent obtained on the world's first submarine electrical pump.

They are complementary also when it comes to capturing international externalities, the not so "free" technology discussed above. The Green Revolution that was so successful in Asia started from research done in the USA by the Rockefeller Foundation and freely disseminated to Mexico, first, and then to India and Pakistan, thanks to the research institutes already in place in these countries. The requirements of adaptation in terms of investment and personnel specialized in technology may be quite heavy. Keller calculates that the smaller a country, the more important is it that it has domestic R&D.[48]

- Second, domestic R&D may not simply be a matter of choice but also a matter of necessity. It is very likely that every country is endowed with some specific factors – probably located in the area of natural resources – that constitute a potentially valuable absolute (not comparative) advantage. Techniques making use of these specific factors would not be available outside that country. For instance, nowhere outside the Andean countries can one find equipment to process llama wool. Specific factors constitute an absolute trade advantage. It would be unwise not to use these factors to seek profit. But the only way to take advantage of country-specific-factors is to develop country-specific techniques. By implication, a domestic R &D capability is needed.

  An example of development based on specific factors is air transportation equipment in Brazil. Thanks to its very large size and low population density, air transportation is vital for Brazil. At the same time Brazilian education, clearly specialized in high-level tertiary education, offers a relatively abundant supply of SET personnel. One result of the encounter between the educational sail and the country-specific transportation need is Embraer, which has now become an apparently successful exporter of air transport equipment.

- Third, the choice between domestic R&D and the import of technology should take into account the social value of R&D as compared to its market value. In some instances the difference may be abysmally large. This is the case, for instance, with general-use technologies in the fields of food, health or environment, where local solutions, adjusted to the needs of local people and using local resources, may be hugely superior to imported equivalents. It is also the case, probably more importantly, with "Orphan Drugs", drugs which are not developed by the market because patients are poor and concentrated in developing countries.

  When the social value of R&D largely exceeds its private value, local R&D may be justified in the public sector, even in countries that are in the imitation phase in private

[48] See Keller, W., op.cit., ibid.

technology. The problem is that public resources may be too thin to achieve an efficient R&D threshold. International solutions should then be sought. A stellar example is the diffusion of the Green Revolution through regional research centres specialized in regionally important crops. The International Rice Institute in the Philippines, the International Center for Maize and Wheat improvement in Mexico, the International Center of Tropical Agriculture in Colombia, and the International Institute of Tropical Agriculture in Nigeria, all established in the 1960s when these countries were very poor, are successful cases of early R&D public goods established in an environment that could not accommodate private local R&D.

3.1.1.2. The flexible agenda of R&D development

The agenda

The three points just reviewed make a general case for the domestic generation of technology, but a general case cannot make be the basis for a policy decision. Domestic generation must be examined within the particular circumstances of the country. In practice, one should, as always in matters of scarcity, check where the comparative technological advantage of the country lies. Is it in the creation, adaptation or imitation of technology? The answer is likely to depend on that country's development level.

At the beginning of the learning curve, when the basic necessity is to replicate what has proved to work in developed countries, the agenda has to concentrate on the establishment of a productive base as large and diversified as possible. At this stage technology does sneak into the country but arrives mainly through the public sector, utilities and telecommunications, and through firms in the primary sector and in commerce. Policies must be designed accordingly. In industry the inflow of technology enters firms through the imitation channel. Hence, it is not specifically R&D that is instrumental in explaining the observed TFP gains but rather non-R&D factors such as learning-by-doing, or expenditures in re-organization or training. The induced effects of R&D may be limited by the merely repetitive character of the overwhelming majority of the surrounding production processes.

As the China case study indicates, the imitation phase need not last very long. As soon as the production scale is right and learning-by-doing is engaged, the gear can be shifted to the adaptation system. Those in charge of giving answers in real life conditions should start with a thorough assessment of the country situation. The first question to ask is: Can the host-economy hope to export enough of the resulting manufactures to finance the acquisition of sophisticated intermediates and capital goods? The second question is whether the sails are there to propel the acquisition of foreign technology. Are there enough supportive R&D and physical infrastructures to operate the sophisticated technology in good conditions? Are there enough people in the host economy capable of doing adaptation R&D? Learning would simply not take place in an environment where qualified jobs are not on offer. As Nelson and Phelps (1966)

have taught us, even the most expensive schooling system will not produce effective skills in a country that is productively backward.

When the production scale is right and learning-by-doing is engaged, i.e., when a productive platform capable of supporting the adaptation system has been erected, the adaptation stage emerges, where firms make R&D efforts to implement better techniques that have been developed elsewhere.

Progressively, as the country goes up along the learning curve and gets closer to the technological frontier, adaptation becomes technologically more sophisticated. An increasing need for investment in product differentiation will emerge among firms capable of discerning possible penetration in as yet untested areas and of covering the risk involved.

Between the imitation and the differentiation stages, the development agenda will have to undergo profound changes. Imitation demands rigid structures that frame large and stable production systems in a long-term perspective, with the purpose of achieving the broadest possible expansion, while the differentiation strategy requires flexibility and, consequently, swifter firms and managerial turnovers.

All of this illustrates that the development agenda has to change along the learning trajectory. Not changing it may have dire consequences. The imitation agenda is likely to have electoral, political and managerial bases with vested interests in the imitation regime. When it comes to switching to an adaptation and later to a differentiation agenda, the resistance of these bases may be fairly stiff. If this is not overcome, the country may remain trapped in the old agenda and miss the wind of development.

Attempts to leap over the imitation stage and to land directly into the adaptation stage may be wasteful. China understood this very well when it opted for the market-for-technologies strategy described in its country study.

3.1.1.3. When is it appropriate to push R&D?[49]

The paean to R&D is universal. One should not, however, take for granted that R&D is always needed. Some voices may have a self-serving interest in claiming that the field is under-financed. Research resources may be allocated to programs operated by rent seekers who are obtaining funds because they have obtained them in the past, and not because they are productive users of these resources, or by "toe-steppers" who duplicate results already achieved by others. Of course, if those who control R&D rents have a say in how public resources are allocated, R&D funds may easily be excessive.

[49] The rest of this Section draws heavily on Betbèze, J.P., Financer la R&D, Conseil d'Analyse Economique, Paris, 2005.

Sometimes the resource-provider institutions are captive not to R&D doers but to R&D users; there are for, instance, ministries or technological institutes that serve mainly to share the non-competitive costs of private firms. It such cases it may not be R&D as such that is excessive but the portion of R&D supported by public funds.

Second, in countries at the adaptation or innovation levels there is evidence of firms that do a kind of R&D that will have no effect on productivity growth. Firms engaged in strategic R&D may use R&D expenditures as a commitment variable that they will use to try to push rivals into over-investing. Firms engaged in innovation races that result in innovation overlapping may use pre-emptive innovation in useless fields, or an overheated pace of innovation (Singapore might be an instance), to keep rivals at bay. These are not growth or welfare inducing expenditures.

If one wishes to build a reasonable case for domestic generation, the first element to take into consideration is the expected performance of R&D; it is an expense that must justify itself.

The way to approach this question is, primarily, to look at the impact exerted by the expense on the technological progress of the host country. This means to compare the cost/benefits of applied research programs. In this exercise the public cost should be calculated to include not only the direct public cost (financing public research or subsidizing private research) but also the indirect cost (tax relief to research or fiscal incentives to savings invested in research) and, finally, the whole gamut of incentives and support that will be needed downstream to ensure that the fruits of research will blossom into innovation.

After the cost, the benefits must be estimated. The benefits expected from additional R&D expenses consist of a shift of the technological constraint and a contribution to the general level of education. According to the endogenous growth theory, the benefits will have to acknowledge the externalities generated by the expense. (The additional R&D capability generates domestic externalities and captures international externalities).

The comparison between the cost and the benefit will indicate whether there is enough domestic R&D. The outcome is an empirical matter about which it is difficult to speculate. However, it calls attention to the fact that most observers claim there is not enough R&D.

3.1.2. R&D policy instruments

3.1.2.1. The policy orientations

Supposing there is a case for increasing public expenditure on R&D, what direction ought this public intervention to take? The previous section indicates that the following guidelines are desirable.

First, the general framework linking the scientific and the technological is a coordinated effort.

The accent here is on the idea of coordination, as a way to keep the communication channels open, without abandoning the merits of specialization and without allowing spheres to overlap. Coordination should encompass all the wheels of R&D. The research sector should not be separated from the development sector. It is true that the principle of free inquiry under the control of the critical review of peers, which characterizes the scientific sector, has little in common with the market allegiance of the development sector. Yet, the interaction of the two and the sharing of resources among them are mutually profitable.

Coordination concerns both the public and the private sectors. In empirical work, research by the public sector shows much less impact on growth than private research. This does not necessarily mean that the public sector is useless for R&D; it may simply mean that it concentrates more in the field of basic research, which is more distant from growth than is the innovation research done by the private sector. But it also indicates that, for the sake of growth, the private sector should be extensively involved. Coordination should also encompass small firms. Contradicting a frequent prejudice, in dynamic economies like the US or some parts of India, a great deal of growth-inducing research is done by small firms. Coordination should, therefore, also embrace the task of eliminating whatever distortions there may be against small firms.

The ultimate goal of this coordinated effort is to achieve a National Innovation System in the vein of Chen and Dahlman's "network of institutions (e.g. universities, public and private research centres as well as policy think tanks), rules and procedures that influence how a country acquires, creates, disseminates and uses knowledge".[50]

Efforts can be coordinated only if the funding targets are distributed according to some commonly accepted order of preference. Funds badly spent are of little interest. There is a need to be selective and structured in the choice of projects and to be vigilant in the monitoring of outcomes. Funds should not be delivered on a first-come first-served principle. Such a principle would preclude scope and scale economies as well as specialization gains. The privileged target is a field where knowledge is cumulative and exerts multiplicative effects.

The difficulty with selecting privileged targets is that the public sector is not necessarily a good industrial strategist. An example of possible pitfalls is the choice between variety-expansion and quality-escalation as R&D drivers. Both versions of R&D benefit the welfare of consumers, but some researchers think that the former version is more of an imitative nature, and therefore leads to slower growth than the latter, which is more of an innovative nature. Taking this assumption, together with the assumption of decreasing returns in R&D activities, it would

[50] See Chen, D., and Dahlman, C., "Knowledge and Development: A Cross-Section Approach", Policy Research Working Paper, No 3366, Washington DC, World Bank, 2004.

appear that subsidies to imitative R&D would increase the share of imitation in total R&D output and, consequently, would retard rather than enhance economic growth.[51]

The selection of targets should probably be left to a tripartite committee formed of scientists, entrepreneurs and representatives of the public authorities. This would make strategic choice within the set of possible options a top-down affair, capable of rallying all efforts in the same direction. However, the set itself would have to be revealed by a bottom-up manifestation of the full spectrum of technologies brewing in all corners of the economy. One way to obtain a broad based "revelation" of the technology potential is the technological forecast technique advocated and implemented by, *inter alia,* UNIDO.

Second, the R&D effort takes place in the context of a general growth effort in which the participation of complementary factors is taken care of, and incentives ensure a convergence of actions towards the common growth objectives.

This means, of course, a concern for an adequate provision of scientific and technical personnel through national and foreign curricula. R&D policy and tertiary education policy are very tightly complementary. If investment in fixed research assets cannot be substituted for SET personnel, then the utilization of these fixed assets is entirely driven by the supply of SET personnel. In turn, if the supply of SET personnel were inelastic to the level of remunerations (because bound by the supply) then any increase of subsidies to R&D would result entirely in an increase in the salaries of the SET personnel at work, without any impact on innovation proper. Accordingly, the decision maker should look for measures to reduce possible rigidities in the supply of highly qualified personnel. This would include structural reforms of the education system (see next section) but also more short term measures like providing the laboratories with information on the supply of qualified personnel, and the job seekers with information on innovating sectors.

The above is a fairly straightforward matter, but there are many other matters where the concern for policy coherence is not so easy to address. Take, for instance, the need to reconcile competition with innovation. Firms may rival each other in their investments in R&D and by competing in the market product. The market may be monopolistic or competitive at either stage. Policy makers may wish to intervene in the market structure in order to foster innovation. Ought they to assume that monopolistic rents are needed to foster innovation or, on the contrary, that competition must be as tough as possible so as to force the firms to survive through innovation? Given the range of possible strategies, no a priori answer is available. Recent research tends to come up with an inverted-U relationship between competition and innovation. One of the models proposed offers the interesting approach of partitioning industries in two classes: one where the rival firms are neck-and-neck in technology and one with technological

[51] See, Davidson, C. and Segerstrom, P., "R&D Subsidies and Economic Growth", mimeo, Michigan State University, 1997.

gaps.[52] In the first class, competition forces firms to innovate in order to survive. In the second class, only the technologically laggard firms invest in R&D, and they will do it with more intensity when the product market is less competitive. Initially, in an economy like that, competition is pro-innovation. However, as competition increases in the product market, the first class is progressively reduced. Correspondingly, the second class assumes increased importance. But, in the second class, innovation is stirred when there is less competition. Thus, the changing composition of industries results in the U-shape mentioned above. Needless to say, the concentration effect of competition is a paradoxical effect for policies intended to moderate concentration by means of pro-competition measures.

Third, the approaches taken upstream, where the level and allocation of resources is decided, and those taken downstream, where evaluation and correction take place, should be based on evidence.

In general, reforms should be oriented towards the introduction of more incentives, more benchmarking, and more evaluations. New projects should be selected on the basis of peer review and continued on the basis of the evaluation of a committee composed of authoritative experts with neutral positions regarding the National Innovation System.

3.1.2.2. The instruments of public intervention are varied.

The instruments of public intervention can be *direct public investment* in scientific research, the financing of scientific staff in research departments, or the financing of scholarships. Here the state seeks to build up a source of public good that will suffuse externalities as incentives to innovation.

The instruments can also be *subsidies* intended to reduce the fixed cost of innovation. These may go to private research directly targeted at specific programs (ideally, programs implemented by laboratories used by innovating firms) or they may support research indirectly through tax relief or tax credits (tax incentives assume that the firm makes a taxable profit in the short term). Fiscal and direct aid seem to be rivals (when one increases, the other decreases) in some countries and complementary in others. Direct aid seems to have a longer lasting effect than does fiscal aid. It has been noted that public interventions in favour of collective learning are better addressed by subsidies than by loans. This is particularly true when it comes to giving innovation incentives to SMEs (because subsidies are more transparent, cheaper to manage and lead more directly to innovation).

These interventions may be *ex ante* or *ex post*. *Ex ante* aid is not conditional upon the success of innovation. Therefore, it is easier to administer and perhaps also more stimulating. *Ex ante*

[52] See d'Aspremont, C., Dos Santos Ferreira, R. and Gérard-Varet, L-A., "Strategic R&D Investment, Competitive Toughness and Growth", CORE and ECON Working Paper, Université Catholique de Louvain, 2003.

R&D tax credits are incentives for the whole population of research firms, unlike ex post aid that only goes to firms that are already successful in innovating. Interventions with ex ante instruments, however, should avoid using public resources to finance efforts that private firms would have made anyway.

More specific instruments like matching grants (co-financing private R&D investment in high social return programs) share the investment risk and reduce the moral hazard. A reward to the innovator financed by taxpayers would, in theory, be an ideal instrument to elicit an innovation and throw it free of charge in the public domain. But it is an impractical instrument.[53]

Instruments of public intervention may also be dedicated R&D loans. Financial markets and even risk capital are not too keen to finance private R&D (given risks with asymmetric information and the long maturation time). The state may accordingly intervene to foster the mobilization of funds.

Given that an alliance between the private and the public sectors is recommended, the question of possible mutual eviction must be considered.

Public and private finance may be complementary or rivals. Public funding of R&D by firms has a multiplying effect on total R&D expenditures when the public funds go to long-term programs. In the case of short-term or frequently modified long-term programs, the multiplying effect vanishes. The multiplying effect becomes more intense as the proportion of public to private funds expands until a certain point (one quarter of total expenditures) after which public funds tend to replace private funds (negative effect).

The public sector also needs to address the factors complementing R&D investments like education, health technology, infrastructure, protection of intellectual property, and so on. In all these domains the question of preserving the general coherence of the policies pursued should weigh heavily on the minds of the decision makers.

The question of intellectual property rights (IPR) is very important in R&D.

The central problem for the public authorities is to achieve optimal property rights that balance intellectual property (incentives to innovators) and competition (incentives to productivity), or, from another perspective, the creation versus the diffusion of technologies.

The probability of successful innovation is low; R&D is therefore risky. If this risk is not compensated, innovation will be less than optimal. The patent offers compensation in the form of a market where the firm can fully exploit the price elasticity of consumer demand because rivals are kept at bay. But, if the risk is compensated too much, consumers will lose (they will

[53] Why would the taxpayers of one country wish to pay by themselves for a good made available to the entire world? How to define ex ante the innovation? How to assess the correct level of the reward without knowing the cost of the innovator? How to know the utility of the innovation without knowing the demand for the innovation?

be paying a rent to the innovator). Hence, the diffusion of innovation will be slowed down (because adapters will have to wait too long to start adapting the innovation).

The ongoing evolution of IPR is worrisome. Legal changes in the US are making patenting ever more extensive and cheaper, and judges punish patent violation ever more harshly.[54] In certain sectors – biotechnologies, software and semi-conductors – patents are proliferating at a very fast speed. The problem with that evolution is that, when patenting is not too expensive and not strictly enforced, firms may practise strategic patenting. Far from stimulating innovation, this strategy hinders it. Even unsuccessful innovators could mine a research territory with patents to harass would-be contenders with costly legal manoeuvres. This strategy can be so effective that firms often use patenting as a substitute for R&D. Thus, instead of supporting R&D intensity, patents are a way to reduce R&D. This patent-intensive strategy is obviously a serious problem for developing countries. The patenting of genes prohibits buyers of genetically modified seeds from doing further R&D; patenting deep software seriously reduces the creativity of shallow software makers, and so on. Technology followers are barred from leaving the imitation stage to pass on to the adaptation stage.

Another delicate question concerns the scope of what is patentable. Ideally, a patent should be granted for a true innovation, rewarding a creative effort. Ideally, also, it should be granted for a specific invention and not a generic one. By patenting a mathematical or a commercial method (say one-click online purchase) a whole sector of activity could be barred from technological diffusion.

A patent policy means deciding what to patent and how to patent it. In this matter, as in any other, the policy responses can differ widely according to the distance to the technological frontier. As the policies may differ so much, the potential for conflict grows. The ongoing burning issues of generic drugs, genetically modified organisms, and software patenting show that no state can take decisions in these matters without regard to the rest of the world. The fruit of R&D is a public good; because it is not excludable, it keeps the door open for free riders. R&D takes place almost exclusively in OECD countries. Developing countries are importers of the fruit of R&D. Technological free riding would probably be general were it not excluded by IPR. With free riding, technological absorption would go faster. Hence, the goal of accelerating growth may induce a sloppy enforcement of IPR in developing countries. If this occurred on a significant scale, innovators would be deterred from offering the kind of technology that is of particular interest to free riders. Fearing a restriction on access to foreign technology, a host country might decide on the strict imposition of IPR. However, this decision introduces monopoly power into the market and, with it, prices above the competitive price and, ultimately, the sub-optimal provision of a good that happens to be a carrier of growth. The real life solution to this problem is to grant protection of the IPR but make it limited in time. With a limited-life protection, one trades slower long-term growth against higher output with the present technology. What are the optimal terms of this trade? In part this depends on the long-term

[54] See Bessen, J., and Hunt, R., An Empirical Look at Software Patents, Working Paper N0. 03-17/R, March 2004.

growth path of the host country. This path can only be guessed because the importer of technology is only in transition to its steady-state growth equilibrium. Under a veil of ignorance, a rule of thumb would be that importing economies with high innovative potential would benefit in general from granting longer patents.

Universal adoption of Trade-Related Aspects of Intellectual Property Rights (TRIPs) would evidently reduce the potential for conflicts. It is not as clear, however, that it would help the diffusion of technologies to developing countries. If direct aid is kept at its present low level, the only hope for developing countries to get close to the world technological frontier is through international diffusion. Hence, it can only be hoped that TRIPs will actually do a good job in this respect.

3.2. Human capital policy questions

Introduction

The questions of human capital policies that will now be reviewed cannot be very distinct from the question of R&D policies discussed in the preceding section. Fundamentally, R&D and human capital are a matter of harnessing knowledge to the service of growth. The National Information System of the preceding section was the tip of the technological iceberg.

The present section will focus more on the submerged part of the iceberg, the National Educational System needed to man the apparatus of technology. This methodological separation should not, however, obfuscate the overarching necessity of maintaining the coherence of the two parts of what should become a national knowledge system. After all, it is from one single budget that funds must be distributed between R&D and primary, secondary and tertiary education.

At the margin of our topic it is important to recall that education is not simply an investment; it is also consumption, something that people want for enjoyment. The long-term historical evidence for this is that literacy rates started to increase before there was any significant increase in economic demand for higher skills. This important aspect cannot be discussed within the confines of this book, but a welfare-conscious society should not ignore it.

To generate human capital, one needs people gifted with creativity and trained in systematic thinking. Hence, expanding the stock of knowledge basically requires the schooling and training of more and more people. The most basic policy question in this respect is whether society needs any intervention by public authorities in promoting schooling and training. This question sounds extremely naïve, given that interventions are universal, but it has the merit of placing the policy issues in a clear perspective.

Examining the question *a contrario*, one could look at education as an entirely private investment. Each person would consider his/her wealth, the cost of education, the earnings forsaken during the years of education, and the marginal returns (in the form of incremental earnings) expected from accumulating years of education in alternative disciplines. On this basis, each would decide whether to invest, in which studies to do so, and how many years of education to accumulate so as to maximize his/her utility function. In this setting, the invisible hand unfailingly stirs the right course of human capital accumulation; public intervention could only worsen, certainly not improve, the decisions take by individuals.

It is well known that in the real world things do not occur in this way. There are two main reasons for this. One is that the returns on education are not well known to the agents – a problem of coordination failure; the other is that even if the agents knew the returns, they could not invest accordingly – a problem of market incompleteness.

3.2.1. The Coordination Failure Problem in the accumulation of human capital.

3.2.1.1. The market rate of return on education.

Evidence of the returns on education comes from empirical studies showing how much more earnings can be derived, on average, from additional years of education. To obtain this information it must be assumed that differentials in real wages are "the marginal productivity" of additional education (this assumption discards the possibility that the differentials would be due to a talent intrinsic to the individuals and therefore independent from education).

Estimations of the rate of return in various places and times indicate that, on average, one year of schooling appears to have a return of 10%.[55] This figure, of course, refers to gross return to individuals from investing in the education of an individual. The net value would be found by deducting the cost of providing the education, the loss of earnings during time spent at school, and by accounting for a lifetime of some forty years.

There is evidence that the return on education changes with the level of education. For instance, Hall and Jones show that the return on year of schooling decreases with the number of years of schooling.[56] Since primary enrolment is becoming universal, the discriminating factor across

[55] See Psacharapoulos, G., « Returns to Investments in Education : A Global Update », World Development, vol. 22, No 9, 1994, pp. 1325-1343.

[56] See Hall, R. and Jones, C., « Why do some countries produce so much more output than others ? », The Quarterly Journal of Economics, vol.114, No 1, 1999, pp. 83-116.

countries will be the post-secondary enrolment and at this level incremental years lose impact on productivity.

Given that the productivity return on education varies with the number of years of schooling, the policy concern that arises is to give enrolment a growth-maximizing dimension. Policy prescriptions should not, however, be based on cross-section results, which are far too general to give any confidence that they could apply in a particular time and place. A safer approach is to address the question from the Nelson and Phelps angle, that the growth effort of any country should be designed in accordance with its position relative to the World Technology Frontier (Nelson and Phelps, 1966). Again, for the sake of contextualization, it would be better not to consider human capital as a homogeneous entity, but to distinguish between various qualities of human capital.

Speculatively, one could make the assumption that the rise in years of schooling beyond the primary cycle would matter more and more as the level of development of the country increases. Countries most distant from the world technological frontier (the imitation stage) would have better returns on investments in the primary cycle; intermediary countries would be better off investing in the secondary cycle; and countries close to the frontier would be well advised to invest in graduate and post-graduate education. In this approach what would matter would not simply be the total amount of expenditures on education but also its distribution across the levels of education.

One intriguing fact that characterizes poor countries is that the return on investment in education does not seem to be higher than in developed countries. A consequence of this is that poor countries do not invest proportionally more in education than developed countries.[57] This flies in the face of the notion that the marginal returns of schooling should be higher in environments where human capital is low. Actually, if, instead of years of schooling, one uses cost of schooling, the returns look even lower (because the remunerations of teachers, which are the bulk of the cost of schooling, although relatively low compared to others in the national market, are relatively higher than in developed countries).

How come that the returns are not higher where the conditions of scarcity are direr?

Why the return on education should not be higher in developing countries is still an unresolved issue. Two possibilities suggest themselves:

- First, it might be due to the relatively short time that has lapsed since high levels of

[57] See Duflo, E., "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment", American Economic Review, Vol. 91, No4, 2001, pp.795-813.

enrolment were achieved. That this variable might count is predicted by the idea that human capital not only depends on the amount accumulated by every individual but also on the average amount of human capital present in the society. This idea, as mentioned earlier, remains to be substantiated. But, in some way, it refers to an incontrovertible truth: that of the necessary interdependence between labour and capital accumulation.

People will invest to acquire skills only in so far as there are firms offering them prospects of returns from jobs requiring these skills. In other words, the set of technologies actually deployed by firms defines the incentives to acquire skills. Similarly, firms will deploy technologies only in so far as they can find labour at the right costs and with the right qualifications. The existence of skills reduces the cost of implementing new technologies and, therefore, provides an incentive to develop new technologies. Human capital and technology are complementary. Granted, to a certain extent they are substitutes, but the marginal productivity of each is constrained by the level of the other.

- Related to this is the question of the informal sector. One of the great impediments to human capital formation is the existence of a large informal sector. Firms in this sector have no incentives to invest in human capital, not only because investing would give them more visibility than they care to exhibit, but also because credit markets are more difficult for them to tap. It is, perhaps, because there is a large informal sector where qualifications make no difference to the remunerations of those employed that the average returns on education look so low in developing countries.

3.2.1.2. The social rate of return on education

As argued by, among others, Aghion and Cohen,[58] the link between productivity gains and education obtained at the microeconomic level may underestimate the real return on education because it does not take into account externalities such as the human capital cross-fertilization between educated people and the externalities derived from the contributions of human capital to technical progress. To take these externalities into account, as one should when talking of economic growth, the link between education and productivity must be considered at the macroeconomic level.

At this level, it has been established fairly clearly that human capital is one of the most important factors of long-term productivity growth. One of the most recent empirical corroborations of this statement says that primary schooling was found to be one of the major sources of differentiation in the growth performance of world countries during the period 1960-2000. A ten percentage point increase in the primary school enrolment rate at the beginning of

[58] See Aghion, P. and Cohen, E., Education et Croissance, Conseil d'Analyse Economique, Paris, 2004.

the period is associated with a 0.27 percentage point increase in long-term growth.[59] Another instance is Oulton's study, which reports that an increase in average schooling years from five to six would increase the long-term growth rate by ¼ of a percent.[60] Others found only a faint contribution of education to growth in the case of developed countries. Krueger and Lindhal (2001) divide the countries of the world into three groups according to level of education. They find that education contributes to growth at low levels but depresses growth when the average worker capitalizes 7.5 years of education. The average worker in OECD countries has 8.4 years of education. This means that incremental education could depress growth in OECD countries while stimulating it in developing countries.

There are few studies that incorporate the quality of education (measured, for instance, by the results obtained at country level in international tests like the PISA test) in the estimation of the link between education and growth. But when this is done it appears that the variable quality is significant and tends to replace the variable quantity in the explanation of the link.

In conclusion, the above evidence suggests that education does influence growth but only faintly in developed countries. However, in countries at lower levels of development the impact is stronger, in particular when the quality of education is taken into account. On this evidence, education appears to be the great catch-up opportunity of developing countries.

The social rate of return on education appears to be three or more times higher than the private rate of return. The difference between the two rates seems to be larger in countries at lower levels of development than in those at higher levels.

Externality is the reason for this divergence. Externality eludes the market. In its maximization exercise, the private agent is led by market signals, not by social considerations. The demand for education finds equilibrium at the number of years that will make the private cost of schooling inferior to the present value of a return of 10% annually on the amount invested.

This criterion determines a demand that governments find generally insufficient for two reasons. The most important is that education is a complex phenomenon involving national cultures, value systems and social cohesion. The second reason is that, in its function of benevolent social planner, the government wants to bring to society the advantage of externalities linked to the accumulation of human capital. It is a function in which the government compensates for the coordination failure that necessarily occurs among private decisions in the presence of externalities.

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[59] See Sala-i-Martin, X., Doppelhofer, G. and Miller, R., "Determinants of Long-Term Growth: A Bayesian Averaging of Classical Estimates (BACE) Approach", The American Economic Review, September 2004, pp. 826-827.

[60] See Oulton, "Total Factor Productivity Growth and the Role of Externalities", National Institute Economic Review, No162, 1997, pp. 99-111.

3.2.2. The Market Incompleteness Problem in the accumulation of human capital.

Private optimization would, in principle, obtain if the rates of return on education truly reflected the marginal productivity of human capital and if, at this true rate, people responded by actually accumulating human capital. But, in order to actually do so, they would need the wherewithal. For a great many people, however, the possibility of accumulating human capital is constrained by market incompleteness. This incompleteness lies in the lack of financial markets where students can borrow against the returns on their future human capital. Future income is too difficult to assess and monitor to serve as collateral. Costly education is constrained by the current resources of households. To the extent that education is costly (the cost of education is not only fees and books but also income not earned during the schooling years) and that households are poor, good opportunities to invest in human capital will go unattended.

3.2.3. Human capital policy answers

Coordination failures, market incompleteness, and the social and cultural dimensions of education together make a clear case for policy intervention. The policy indication is clear: education and training should be supported.[61] The domain of action for policy can be divided into three parts. The quantitative and the qualitative sides of the supply of human capital comprise the first two parts; the third part is the demand for education.

3.2.3.1. Delivering the right quantities

Quantitatively, human capital may be measured by the average number of successful school years per individual. Our case studies show a considerable increase in all sorts of school enrolment indicators in the course of the four decades. Chile, for instance, doubled enrolment. In China the illiteracy rate declined from 34% to 7%. In Brazil the proportion of the labour force with some college education grew from 1.2 % in 1960 to 4.2% in 2000. In Mexico the average years of schooling increased from 2.6 in 1960 to 8 in 2004.

The resources needed for education are considerable and compete with other resources like health and social security. The size of public resources thrown into education should therefore be optimized. A country far below the world technological frontier would rely more on factor accumulation than on technological change and could, therefore, do with less human capital

[61] Regrettably, the subject of training cannot be covered in this book. Training, either in the implicit form of learning-by-doing or in the explicit form of training programs delivered by firms or specific institutes, is certainly important. There is an abundant literature that demonstrates this in the case of developed countries (see Isaksson, op.cit.). The omission, however, is not so tragic because, of the two, learning is clearly the major source of cognitive competences, which is the form of human capital formation that really matters in terms of technological progress.

than a country on the border. In more practical terms, the endowment of human capital in any country should be consistent with the amount and sophistication of technology in use in its economy.

At early stages of development, intense efforts to ensure 100% primary education are certainly justified. Human capital accumulation need not be biased towards higher skills. Pyo, the author of our country study on South Korea, is convinced that the effort made by South Korea in the sixties to fully enrol the population in primary education was the fundamental cause of South Korea's exemplary growth. He says that primary education counts mostly as a factor that enables the basic productive capacity of people, rather than as a base of human capital on which to build later.

After primary education, parsimony enters the scene, in the sense that, from a purely economic point of view, the demand side of the economy should guide investment in education. As development picks up, the response of secondary and tertiary education will have to be quick to avoid bottlenecks. Because of the long time needed to build up human capital and given that when growth starts the demand for qualifications would outgrow the growth output, authorities must keep a constant watch on the medium-term evolutions so as not to be caught with an insufficient pipeline of qualified personnel. Following Pyo, it would seem that the Asian Tigers, in general, owe much of their success to state intervention in a timely expansion of primary and secondary education of high quality.

Inversely, many stagnating economies seem burdened by a plethora of highly skilled personnel maintained in hidden unemployment because of a lack of proper jobs. To the extent that these people were educated thanks to foreign scholarships, the burden may be tolerable. But if their education was at the expense of national resources, it can only have had a depressing effect on growth. Similarly, those educated nationally but working abroad represent a misallocation of resources, even taking remittances into account.

It is not only the level of development that is relevant when it comes to defining the right stock of human capital and the right qualitative features of education and training. Also relevant is the productive specialization of the country and its reliance on imported technology. For instance, a resource-based-specialization country like Chile does not seem to require as much human capital as a country specialized in manufacturing, like South Korea, in order to achieve a given rate of growth.

3.2.3.2. Delivering the right quality

Many developing countries report high achievements in school enrolment but complain about the quality of their education system. Actually, quantity and quality may well be rivals. This is a time of mass education. Everywhere in developed as well as in developing countries, enrolments in the education system have increased hugely in proportion to the population. This expansion has placed considerable strain on public budgets already pressed to accommodate

competing needs in the areas of health, social security and infrastructure. In real terms the per capita resources per student are, today, markedly smaller than four decades ago. At the same time the resources required to catch up with the technological gap are on the increase. From this comes a dilemma: good education for the happy few or mediocre education for all. No side of this dilemma is acceptable. This, universally, places the education system under heavy pressure to achieve structural reforms oriented towards efficiency.

Efficiency is meaningful only in relation to guidelines. These are the first things to look for. How should the size of enrolment be determined – according to those who wish to study, to those who have a good chance of being successful, to the needs of the labour market, or to a certain proportioning of public and private sources of financing? Once clear views are defined, efforts may start. Structural reforms take a long time to be implemented and to deliver results in systems so widely and deeply anchored in the cultural and social conditions of a society. This means that the efforts should start without delay. Here are some directions that these efforts could take:

- An important direction of reform is to reshape the domain of action of the public sector. The public sector should release the activities that can be better performed by the private, in order to save the resources to invest in infrastructure and human capital. The limit to this re-structuring is set by the minimum presence of the public sector needed to ensure the monitoring and evaluation of the private sector, and perhaps to ensure a competitive pressure on that sector. Having state subsidies combined with private delivery services and an appropriate regulatory framework would seem to be a general principle in this matter. In practice, however, an important word of caution should be sounded. When governments pay private providers to deliver services to private citizens, there is scope for corruption and abuse. The scheme would only work in environments with very strict governance. Otherwise, alternative schemes should be preferred.
- *The teachers.* Improving the delivery of the education system passes through several channels. These channels include some marginal adjustments like the teacher/pupil ratios, or the expenditures per capita on equipment (computers) and teaching material. But the human capital of the teachers and the system of incentives that drives their productivity, and the mix of subjects on offer seem to be much more important.

  In countries complaining of poor educational performance, teachers are typically remunerated at lower levels than other professions but kept safe from market tribulations. None of these two characteristics leads to good performance. Wherever possible, the relative remuneration of teachers should be brought to a level capable of attracting real competences. At the same time competences should be judged on the base of evident results. The status of teachers should be approached more flexibly. Those with good results should see their contracts renewed and their remunerations increased (and inversely).

In some countries teachers are well enough organized to extract advantages from their collective scarcity. This creates a situation where the wages of teachers absorb an inordinate part of education expenditures and teacher efficiency is hampered by absenteeism. This situation ought to be re-negotiated at a national level in the direction of linking remuneration to achievement.

- *The schools.* Schools are more or less efficient organizations; they can be well managed or badly managed; their facilities can be more adequate or less adequate. Within schools the classroom management, the learning material, the instructional methods, and the socioeconomic status of the school population are relevant quality attributes. To approach optimization, the allocation of resources to schools might seek the help of market signals. The capital to be invested in schools would pass through a decentralized organization that would decide on its allocation based on evidence provided by observation of performance. Schools would be given autonomy. To ensure efficiency, they would be submitted to the sting of competition. Their performance would be made visible. In the UK, for instance, the quality of schooling is evaluated by an independent agency, based on various criteria (curriculum, teaching, student results, support for students, learning resources, and the quality of management). In addition to the independent agency, there is a public benchmarking of the multidimensional efficiency of the education system. In the case of universities, for instance, performance is measured according to access to graduates, rate of failures, actual time to obtain diplomas, rate of employment after six months of graduation, and so on. In such a system, the parents and students should have the means to choose among schools. Enrolment would signal the best schools and attract resources to them. Provision should then be made to close and replace failing schools.

  It has been noted that the countries that perform best on PISA tests are those that do not care to let under-performing students fall behind. Schools that address the problem of under-performance by having students repeat the same grade have failed to show convincing results. The solution appears too lie in developing specific support for students in need.

- *The curricula.* The quality of the education system lies not only in the efficient delivery of the subject matter but also in the right selection of subject matter. It must be congruent with the mix of skills likely to be demanded in the labour markets. It must also be congruent with the likely externalities that can be derived from the participation of students in an intellectual community. These norms show that the regulation of the educational content cannot be left to market decisions exerted by students. It would be a waste, for instance, to admit subjects matter that cost more than their value but were demanded by students because the chances of success are higher.

  A way to regulate the supply of content is to coordinate education and research as much as possible. Ideally, the education system should anticipate the likely shifts of technology. At the very least, it should translate the shifts of technology into the subject content and curricula as briskly as possible. Apparently, the universities of the United States may

serve as examples in this regard. Of course there is a risk when education is committed in a specialized direction. Flexibility must be maintained in the face of an uncertain future; but reasonable bets must also be taken. For instance, in societies engaged in globalization, the general teaching of English or of computer knowledge seems appropriate.

Regarding the selection of subject matter, it is noteworthy that there is a world trend towards saving on un-skilled labour. This trend can be observed in the fact that, across the industrialized world, the real wages of young men with less than twelve years of education have fallen markedly. This is because the employers' demand for skilled workers has been rising over time. Some industries have experienced faster skills upgrading than others, but all industries seem touched. The near consensual explanation for this evolution is skill-biased technological change, which is a form of progress that shifts the production function in favour of substituting high-skilled labour for low-skilled labour.

This trend is also operative in developing countries. There, however, it creates more difficult problems. High skills are relatively more expensive than low skills, given the typical endowment of a developing country. Therefore, the substitution rate (the quantity of low skills to be discarded to allow room for an additional unit of high skills) is higher. Tensions on the labour market are foreseeable when a developing country catches up with the technological frontier. The relative demand for high-skills tends to create large discrepancies between the wages of general workers in favour of SET workers. Sometimes even a flexible response on the part of the supply of skills is not enough to reduce these tensions. This is due to the innovation needs induced by the very expansion of high skills on offer (our country study reports that in Brazil training and school attainment are two of the four variables most closely associated with the probability of innovation). As more SET personnel arrive on the market, firms are induced to undertake more R&D investments. To operate the new assets, more SET personnel are then needed. A dynamic is set in motion. Thus, the additional SET supply actually aggravates the tensions that it was supposed to relieve. Consequently, countries approaching the technological frontier are recommended to organize a technological watch capable of offering an early warning to the educational system.

- *The financing of education.* The question of financing is probably the most important one in terms of its impact on value (of human capital in the society) for money (spent by society on education). The range of possibilities is wide. The two extremes are that education is financed entirely by the government or entirely by the market. If education is entirely free there will be inefficiency in the sense that students with no talent to learn will be allowed to use the scarce teaching resources available, at the cost of inadequate provision for gifted students. If the market prevails, students who have talent but are poor will have no access to education. Between these extremes lie intermediary solutions. One gaining a lot of interest includes non-trivial entry fees combined with loans reimbursable on future earnings derived from education. This formula makes the students pay for their education. It may therefore penalise poor students who would have to undergo years of

study without earning, for a hypothetical income (unemployment may be waiting, failure may occur) diminished by the reimbursement of the loan. Subsidies are an obvious solution but subsidies to poor people are difficult to manage and stigmatize the recipients to the point that they may not even wish to claim their rights.

3.2.3.3. Caring for the demand side of education

Ensuring the supply of education is only one part of the problem. The other part is ensuring that people engage in education. As discussed above, one of the reasons why people would want education is its return on investment. The discussion above was, however, confined to returns in terms of income. But there is a wider meaning of returns. In particular, there is a return in the sense of social mobility. Our case study reports that in Brazil, between 1992 and 2002, 44% of the increase in total family income came from the better qualifications and higher wages that more education enabled workers to achieve.

In addition to such returns, education enrolments are guided by other factors. It has been suggested that lower mortality increases the return on education even without technological change. *A contrario*, plagues like Aids may be expected to damage growth through the depreciation of human capital. Health impacts on TFP growth directly through households' income and wealth, and indirectly through labour productivity, savings and investments, and demography by reducing various forms of capital and technology adoption. Healthy workers are more productive than unhealthy ones, all else being equal. With lower mortality rates the incentives for saving increase, leading to higher TFP growth. Foreign investors do not like environments where workers face a relatively high disease burden; some countries are thus deprived of potentially productivity-enhancing foreign direct investment. In addition, healthier children have higher school attendance rates and better cognitive ability. Furthermore, a longer life span is likely to increase the attractiveness of human capital investment.

Let us further develop some of the links mentioned above. Take health and labour productivity. If a disease such as AIDS affects the labour force proportionately across different levels of skill (and there is evidence that this is indeed the case), for developing countries with low levels of human capital, i.e., most developing countries, the effect on labour productivity, and most likely overall productivity, is devastating. Take AIDS and savings. Although the net effect on savings rates may be ambiguous (there is increased use of savings when income goes down, but households tend to save more because future income flows are uncertain), there is a significant risk that AIDS reduces national savings rates, which means that investment and hence capital accumulation decrease. Under such circumstances, the scope for productivity growth is undermined and economic regression may ensue.

Another example is health and schooling. When illness or death strikes, children are taken out of the educational system in order to replace the family income generator. The general level of human capital decreases; part of the capital stock goes unattended. Finally, consider health and public investment. As a larger part of the government budget goes to health-related

expenditures, less is available for the necessary upgrading and maintenance of, for instance, the infrastructure and the educational system. Hence, the private sector will find less support from the government for productivity-enhancing activities.

Another important factor is the density of population. Higher density can lower the cost of education through facilitating the creation of schools. Inversely, a lowering of fertility may weigh against human capital by increasing the fixed cost of education to be supported by every student.

3.2.4. Policy instruments to support demand for education

Evidently, a fiscal policy of taxes and transfers can play a role in supporting demand for education, as can a specific policy of education finance, for example, subsidies to poor students, free public education, subsidization of private schooling in poorer communities, free transport within a reasonable radius, and so on. Another approach is to have labour institutions and public policies directed at the poorest workers, for example, minimum wages, redundancy compensation, more public sector jobs, and so on. The socioeconomic status of the students and of their parents is an important factor in the level of school achievement. Hence, value for money in matters of education spending largely depends on the way inequality is addressed, including ethnic inequality, for instance, discrimination against bilingual indigenous education.

No matter the approach, these are all subsidy policies. A policy of subsidised education implies, of course, a policy of progressive taxation. This leads to the issue of redistribution.

First, is there not a certain contradiction between the two? It may be argued that the redistributive aspect of progressive taxation may reduce the incentive to invest in education. This argument is well taken. There is probably some degree of conflict here. Yet, the resulting impact may still be a positive one for the demand of employment. All will depend on the trade-off between the distortions introduced by redistribution and its beneficial effects on access to human capital. If the distortions are small and the financial constraint on education is strong, the redistributive policy will have a relatively strong effect. That principle remains valid whether the tax takes the form of reduced benefits downstream or direct contributions upstream (actually, private decisions to invest in education are undistorted if the tax rate on the additional earnings associated with education is equal to the share of subsidies in the total investment cost). In any case, there are reasons to believe that the impact of redistributive policies could be powerful. Bénabou calculated that a redistribution of 6% of GDP raises the long-term growth

rate by half a percentage point despite a reduction in the supply of labour.[62] Alternatively, a progressive fiscal policy to finance education raises the long-run growth rate by 2.4 %. In both cases the top 30% subsidizes the bottom 70% of families.

The degree of redistribution and who ultimately pays whom depends naturally on the financing system considered and on the characteristics of the society. The outcomes can vary widely. Completely free high education, to take an apparently uncomplicated example, will be either a loan or a transfer according to social circumstances. It is a loan if those who graduate will ultimately pay back their education to society in the form of progressive tax rates on the superior earnings that superior education brings. It will be a transfer if access to education is sociologically discriminated. Taking inspiration in Rawlsian fair equality of opportunities, it can be said that the condition for not having sociological discrimination is that, no matter what social category a person belongs to, his chances of getting an education are equal to the chances of a member of any other category: man or woman, poor or rich, foreign or national, and so on. Of course, if education is a transfer from the general public who foot the bill for a social elite that gets privileged access to education and its better earnings, free superior education becomes an instance of regressive redistribution.

Redistributive policies are always likely to meet resistance. One of the deepest determinants of their acceptance is the degree of equality characterizing society at a given moment of time. The range of possibilities seems to exhibit a U-shaped form. In a very equal society, income redistribution is likely to take place. With income distributed more equally, the poorest part of the population can then address the question of financing the acquisition of human capital mentioned earlier on. Since the average stock of human capital increases, the accumulation of physical capital also accelerates. The outcome cannot be predicted, but one possibility is a relative increase in the economic strength of capital owners. With more social inequality, the proportion of voters that might lose from redistribution also grows. This may lead to more inequality, less redistribution, less access to human capital, a deceleration of growth, a loss of strength of the capitalist, an increase in the numbers of poor, and, ultimately, a return of redistribution policies. Within the range of possibilities, some correspond to sustainable equilibriums. It is, for instance a long-term constant that the US tolerates a certain degree of inequality, Anglo-Saxons a little less, continental Europe somewhat less, and the Scandinavian countries much less. In developing countries, some seemingly fail to find equilibrium, as suggested by instances of sustained oscillations.

It was mentioned earlier that the technology elaborated in advanced countries, i.e., virtually all technology, is biased towards high-skills. This bias makes redistribution a more difficult social

[62] See Bénabou, R., "Tax and Education Policy in a Heterogenous Agent Economy: What Levels of Redistribution Maximize Growth and Efficiency ?", Econometrica, No 70, 2002, pp. 481-517.

goal. Highly skilled workers, sensing that the future places a trump in their hands, may break out of solidarity with the rest of the working class. Politically, this "defection" makes redistribution, and hence the acquisition of human capital by the poor, more difficult to achieve. If so, it may be said that the skill bias of technological change feeds back into a slowdown of technological change via a restriction on the build up of human capital.

This question is thought to deserve a lot of attention. Recent growth episodes in countries like Argentina, Chile, and India seem to combine highly skill-biased production processes with exclusion of less qualified workers from formal productive activities. This evolution has its logic. A heterogeneous labour force curbs aggregate productivity (low skilled workers cannot attend to the requirements of sophisticated processes set up by engineers and technicians). Consequently, firms tend to separate processes into segments of homogenous skills (with outsourcing and reorganization). However, this trend results in a differentiation of wages and confines the less skilled workers to income levels from which human capital is inaccessible. This is why countries that limit access to education to those who can pay for it (private financing or financing through taxes on local communities) may fall into a technological trap. Skill-biased technological progress requires more skills but at the same time evicts part of the population from education. If education is not easy to finance, those that have nothing invest less in education in times of growth because they are better remunerated in low-skill jobs than if they financed their education.

3.3. Conclusions

This chapter has identified the space and means for policy intervention in the two domains signalled by growth theory, namely, technology and human capital. R&D and human capital have been examined successively as if either were the primary engine of growth. This has been done for the sake of presentation. The chapter states, however, that in real life these two factors interact.

In terms of policy this means that interventions should simultaneously encompass all the factors responsive to the stimulus of the intervention. For instance, governments may want to subsidize both education and R&D. If only one domain is targeted, the effectiveness of the single instrument used will be diminished. The impact on growth of subsidies to education (or R&D) will be constrained in the long run by the responsiveness of R&D (or education) to the impact of the subsidies on the supply (or demand) of skills. Intervention is recommended when provision of a factor is sub-optimal due to market failure. The intervention must aim at optimality. This principle means that over-optimal provision would also be a waste – more or less depending on the circumstances. This should be kept in mind when the "needs" required to achieve predetermined development goals are estimated.

Interventions should be tailored according to the country's current level of productivity. The ratio of R&D to production in total investment and in the use of skilled labour should grow as the country moves closer to the world technological frontier. Similarly, the composition of

educational expenditures should shift in favour of secondary and tertiary schooling as the country gets closer to the frontier.[63] Pro-activity is recommended in the case of primary education and reactivity, but swift reactivity, in the other cases of intervention lest the windless economy is burdened with useless sails.

[63] See Aghion, P. and Howitt, P., "Growth with Quality-Improving Innovations: An Integrated Framework", Draft for the forthcoming Handbook of Economic Growth, September 20, 2004, for a systematic analysis of the interplay of growth and its determinants as the frontier is approached

Chapter 4: Policies to support the more distant determinants

Introduction

A big effort in technology generation and the development of human skills, sustained over several decades, is capable of increasing the productivity potential of an economy.

This potential is a dimension that defines the space of possibilities. Within that space the economy occupies a certain position, ideally as close as possible to the maximum realization of the potential. As is all too well known, economies can function briefly or even lastingly below their potential. This raises the question of the determinants of the actual utilization of the productivity potential – the rigging – of an economy. That is what this chapter now looks at.

As mentioned earlier, due to the general interdependence of economic matters, practically any aspect of economic life may be considered to have some influence on the utilization of the productivity potential of an economy (in short, productivity performance). The regression from determinant to determinant must, however, stop somewhere. Systematic analysis ought perhaps to be employed to select the relevant determinants, but theories encompassing a great number of variables are not available, and, in estimating parameters, degrees of freedom get lost with the inclusion of many variables, and co-linearity sneaks in.

Here we will adopt a somewhat eclectic strategy of focussing on determinants that have been highlighted in Chapter 1 for their probable impact on productivity performance. According to the country studies, three conditions are required for good productivity performance: macroeconomic stability, structural and microeconomic reforms, and good institutions. To use a catchall formula, the integral of all these determinants will be called the business environment. This chapter intends to review these conditions in the search for the characteristics of the business environment that are favourable to a good utilization of the productivity potential.

In the first section, the three domains will be examined at the level of the whole economy, and, in the second, a close up will shift the attention to the micro foundations of the business environment.

4.1. The business environment in the whole economy

4.1.1. The macroeconomic framework

Examining the evolution of TFP in various national contexts, one is led to think that productivity performance is clearly under the influence of macroeconomic stability. More stability means higher TFP. Moreover, it also appears that factors other than stability that have a

positive influence on TFP exert a stronger influence under stable macroeconomic regimes than otherwise.[64]

Considered in the short run, i.e., in the course of too short a period for structural parameters to change significantly, productivity appears to be under the influence of factor utilization or returns to scale. Since production capacity remains largely unaltered, adjustments of the basic macroeconomic variables (supply and demand, saving and investment) are left to the care of variations in the quantities of factors used and the amount of output. Variations of output within fixed capacities seldom occur at constant returns to scale (the variations of inputs being often less wide than the variations of output). Hence, productivity fluctuates. A recession phase in the business cycle or a balance of payment choking under the impact of some random shock, for instance, would decrease output before input utilization could be curbed, with a resulting decrease of productivity. Moreover, variations in output or in factor utilization would normally drive adjustment costs, and these costs, in turn, would have their own impact on productivity.

Short-run fluctuations of productivity are pervasive (at one time or another all countries are affected) and frequent. As just said, these fluctuations entail adjustment costs. While short-term costs are not supposed to have an influence on the size of the economic potential of a country, they can be detrimental if they drag on in the long term.

In this respect, three possible long-term consequences of short-term fluctuations are particularly worrying.

- First, *risk aversion* may increase in the economy. Firms and households adopt precautionary behaviours that are rational given the unstable circumstances but detrimental to the growth of the economy. Households may over-save (restricting the finance of investment), and investors may require a risk premium (restricting investment to the smaller number of projects offering a higher rate of return).

  Risk aversion tends to last. Capital markets, for instance, do not easily forget the losses due to crises, or forgive the defaults and confiscations they impose. It has been calculated, for instance, that the capital stock of Argentina in 2003 was twenty percent lower than in 1980. That means forty five per cent lower than its trend value. That implies that the productivity and real wages of today's workers are much less than were those of their parents.[65]

- Second, *structural underemployment* may increase in the economy. To a certain extent the qualifications of workers are the fruit of the particular circumstances of their job. When

[64] See Fuentes, R., Larrain, M., and Schmidt-Hebbel, K., "Fuentes del Crecimiento y Comportamiento de la Productividad Total de Factores en Chile", Central Bank of Chile, Working Papers, No 287, December 2004.

[65] See Kydland, F., and Zarazaga, C., "Argentina's Capital Gap Puzzle", Federal Reserve Bank of Dallas, Center for Latin American Economics Working Paper.

the job is lost the job-linked qualifications are lost, too, and it becomes more difficult to find a new job. The workers lose assets sunk in their past experience and therefore become less employable.

- Third, *productive assets may be destroyed.* The firms that are destroyed by recession are not necessarily the less efficient firms. Firms that have taken innovation risks or that have started on a precarious financial base may have to exit the market notwithstanding their good economic potential. In such cases, tangible (equipment) and non-tangible (know-how) assets will almost certainly suffer damage or loss.

- There is a risk, however, in trying to avoid these consequences of short-term fluctuations. Too much stabilization might hinder the cleansing virtue of recessions. Recessions have this merit of evicting less-performing incumbents, thus allowing room for more efficient newcomers. The exit of less efficient and the entry of more efficient firms increase the average productivity of the economy. In so far as the assets of exiting firms can be re-employed by new entrants, no social loss is involved and recessions leave a purified background for further growth. Evidently, in such circumstances recessions should be allowed to do their work of destructive creation.

Given the possible social loss considered above, what should the policy response be?

Macroeconomic stabilization

In so far as it prevents short-term fluctuations or shocks, macroeconomic stabilization is, of course, pro-productivity. But it is only a necessary condition. Whether recessions are going to be pro-efficiency, or the reverse, depends to a certain extent upon the business environment. Where labour markets and financial markets work well, the lasting cost of recessions may be expected to be less because firms will have better chances of borrowing, and workers better chances of finding a new job. If the factor markets are rigid or badly informed, the recessions will take heavy tolls on the way to growth. Hence, pro-productivity stabilization is a multidimensional and sequenced affair.

A rough sketch of the varied experiences of many countries may show that stabilizing the economy is usually a battle on three fronts: reducing the fiscal deficit, balancing the external accounts, and fighting inflation. Strategic actions usually include a devaluation of the currency and an anchoring of the exchange rate (various anchors or combinations of anchors are on offer), a disciplining of monetary policy, and a reduction of fiscal expenditures on subsidies and non-essential programs. Treaties are concluded to open the country to international influences, Barriers to trade are lifted, foreign investment is invited, and TRIPs are adopted. The home front is sanitized. Financial intermediation is liberalized, and the banks are reinforced. The state privatizes the enterprises it controls and the various services it operates. The tax system is made more efficient. The labour market is made more flexible. Market distortions are reduced and

competition is enhanced. The institutions are overhauled in the sense of having more property protection and a better rule of law, less corruption and red tape, and better governance.

A reasonably good framework of dispositions to watch against fluctuations consists of a floating exchange rate; a deep financial intermediation to disperse the risks; a credible medium-term anchoring of inflation expectations; and a credible and sustainable fiscal balance with favourable public debt dynamics.

The implementation of this stabilization program has, without doubt, shown much progress in many developing countries in the last twenty years. Previously, most countries used to suffer from endemic macroeconomic imbalances with the attendant inflation and balance of payment problems. Now, many countries care a lot more for the crucial balances between saving and investment, on the one hand, and supply and demand, on the other. They are a lot more open to international interdependence, and pay a lot more respect to the demands of efficiency, in terms of freer market forces and more realistic prices. To the extent that it depends on the fundamentals of the domestic economy (and not on political or external shocks), macroeconomic stability is now safer than in the past. This new stability is a pro-productivity development in the passive sense that it keeps anti-productivity forces at bay.

Redistributing instability risks

Macroeconomic instability is, no doubt, a source of considerable stress on incomes related to jobs and on replacement incomes. Short-term fluctuations will never be completely avoided. In fact, it seems that the future is becoming more uncertain.

Hence, minimizing the consequences of instability would appear to be a good idea. One way to do that is to share internationally the macroeconomic risks borne by individual countries.[66]

The growth rate of national incomes per capita varies substantially across countries and over time. Convergences can be observed among certain clusters of countries but these convergences take place around trends that are themselves subject to much uncertainty.

If individual country risks were pooled and then shared internationally (according to each country's degree of risk aversion), ex ante welfare gains could be expected. What is more, in a scheme whereby the winners of the future compensate the losers, the prospective welfare of all participants would be enhanced at once, no matter what the outcome may be. This means that the scheme would be regarded as a public good and would, therefore, be easily accepted by

[66] More on this in Drèze, J.H., "Jobs and Economic Security in the 21st Century", in H. Loeffer and E.W. Strewissler, eds., Sozialpolitik und Oekologieprobleme der Zukunft, 65-96, Oesterreichische Akademie der Wissenschaften, Wien.

society. This is often not the case with schemes that rely on ex post taxation of the better off to alleviate the misfortunes of the worse off.

As yet, this proposal is a Utopian one. But it is a positive Utopia, one that can, in principle, be conjured into existence. In theory, one could contract out macroeconomic risks by selling perpetual rents proportional to GDP indices. Countries would create efficient portfolios of these bonds by trading among themselves.

Admittedly, the implementation raises many issues, some of which are as yet without solutions. These are mostly issues of moral hazard. To what extent would the incentive to pursue growth be reduced for a country that had placed claims on its national income in a pool of which it owed only a small part? To what extent would future generations be tempted to flout contracts passed on by earlier generations even if this were for the benefit of the future generations? There are also issues of monitoring and enforceability. But the point of a Utopia is to offer a vision and to engage a debate.

4.1.2. Investment

TFP and investment have a mutual influence on each other. Productivity is a source of investment because it entices investors to take advantage of the marginal productivity of factors. But investment, albeit primarily accumulation, is also a source of productivity (the growth determined by investment allows diffusion of technologies). The global picture in Chapter 2 of this book shows that the key to productivity growth is capital deepening. Accordingly, pro-productivity policies include pro-investment measures. These measures can take three directions: lower the cost of capital; channel savings to investment; and build up infrastructure.

4.1.2.1. The cost of capital

Investment will increase if the cost of capital to investors can be reduced enough to generate an additional demand for investment funds. The impact is a question of elasticity. For instance, with an elasticity of 0.7 between interest rate and stock of capital, a decrease of 14% of the cost of capital would generate an increase of 20% of the stock of capital.

How could a government reduce the cost of capital? The instruments of choice are capital tax reduction or more generous depreciation regimes. Provided these incentives are granted for a long duration, a sustained increase in the investment rate can be expected (short-term measures would only accelerate the calendar of a given flow of investment).

As seen in the preceding point, another way to reduce the cost of capital is by gaining the confidence of investors and thereby reducing the risk premium, which is an integral part of the cost of capital.

As stated above, stabilization is a great means to gain the confidence of investors. A country exhibiting low inflation, fiscal balance, a strong financial system, good institutions, etc., is a country that inspires confidence and enjoys a low spread between public debt and US bonds.

One seemingly vital aspect of confidence is the degree of continuity of the characteristics of the business environment. Kydland and Prescott[67] have explained that benevolent and well-informed governments would very often refrain from doing what they announce they would do.[68] This is the time-consistency problem. Agents are aware of the tribulations of discretionary governmental policy-making; hence, they will trust only governments institutionally bound to do what they announce they will do. Policies are trusted not because they are good policies but because they are policies guaranteed to last.

But confidence can also go too far. Misplaced confidence can lead to under-pricing of capital. Exceedingly cheap capital leads to excessive accumulation of the stock of capital and, ultimately, to crises in the manner of the mid-1990s Asian crises.

The right level of confidence should be based upon an objective evaluation of external risks. And, in this respect, it has to be assumed that international risks are on the increase in a world subject to radical changes. Examples include, for instance, the meltdown of asset prices; the bankruptcy of large corporations and of large hedge funds; and the wide fluctuations of real estate prices. In response, the international financial system has been highly innovative. But it has also become a lot more opaque. So far, the intricate set of interconnections established through the use of derivatives, challenges any attempt at deciphering it.

Lowering the interest rate can also stimulate investment. The real interest rate can obviously be influenced by domestic macroeconomic policies but it also depends on foreign interest rates, on inflows of capital, and on the exchange rate. In short, regulating the interest rate is not quite a discretionary matter. But, if the circumstances allow it, a lower interest rate would stimulate investment through the credit channel. In developing countries, investments are largely financed by bank credit. However, it is well known that banks tend to ration credit and that rationing is inefficient because small borrowers are discarded even if they have a good probability of reimbursing their loans. Lower interest rates will reduce this selection effect and generate some efficiency gains.

Interest rates can, however, be too low. In South Korea, for instance, a policy of financial repression – maintaining interest rates at artificially low levels – was practiced for a long time, and in Argentina negative real interest rates prevailed in the eighties. The cost of financial repression in terms of inefficiency is severe. The shallow financial intermediation generates an

[67] See Kydland, F., and Prescott, E., "Rules Rather than Discretion: The Inconsistency of Optimal Plans", Journal of Political Economy, vol. 85, No3, pp. 473-491.

[68] Imagine a government that, in order to promote immediate investment, announces an increase in interest rates. Investors respond by investing before the increase. Since the desired investment has taken place, the government now finds that it is better not to increase the interest rate.

arbitrary assignment of financial resources that is not likely to place resources where the consumers see good value.

4.1.2.2. Savings

The work of MacKinnon in the seventies has made it clear that financial repression and savings are mutually adverse. Avoiding this mistake is then a pro-saving policy. In addition, a country should try to be in a position to borrow on the international market (i.e., inspire confidence in its stability, develop its financial market, avoid exchange controls). But there is only so much that international capital markets can do to finance investment. What can safely be borrowed on a sustainable basis for investment purposes is limited to a modest portion of GDP. Anyway, inflows of foreign capital push the exchange rate upwards with a consequent loss of competitiveness. The accent must therefore be placed on the mobilization of domestic savings.

It is not easy in practice to increase the rate of savings of an economy. One measure, however, is often presented as successful: the introduction of a fully funded capitalization pension scheme. In a capitalization scheme workers contribute to pension funds that are partly or totally invested in financial markets. Almost all existing public pension plans embody a substantial unfunded pay-as-you-go component. The implementation of a fully funded scheme in a country where repartition schemes are already in use is, however, exposed to transition problems. Previous to the reform, funds must be amassed to cope with the attrition of the system in place, because the flows of contributions dry up while benefits must continue to be paid to retirees.

Besides transition problems there are implementation problems. One issue is the creation of suitable assets in which to invest the fund balance. A good policy principle is to invest the fund balances in a fully diversified portfolio of marketed assets, including stocks and bonds. But the application of this principle is constricted by market incompleteness. Typically, traded assets are only a small fraction of total GDP and they are relatively risky assets.

Another issue is coordination failure. If savings are to increase, this is to meet an additional supply of real investment. But the accumulation of retirement reserves is equivalent to the accumulation of public debt, and the accumulation of public debt increases the interest rate. Yet, investors, as seen above, need to see a decrease of capital cost if they are to demand more investment funds. Thus additional aggregate savings could reduce investment. The paradox is that savings would reduce investment in a context of underinvestment. In such a case a portion of available resources remains unutilized.

The issue would then arise of stimulating activity through aggregate demand until absorption of the excess savings. In small open economies demand stimulation is, however, limited by international propagation of the incremental demand.

4.1.2.3. Infrastructure

Public expenditure can be productive,[69] not only directly but also indirectly. Spending on fixed infrastructure assets generates externalities that raise the return on private investment. For instance, infrastructures in technological sectors (e.g., mobile phones, satellites, Internet) and in communications are supposed to generate a lot of externalities for firms that seek to integrate with the global market. What is more, infrastructure brings capital within the reach of poor people precisely where they can make a contribution to TFP. Electricity means more time for study, roads mean better access to schools, water means better health.

The contribution of spending on infrastructure (in particular, transport, telecommunications, and energy) to growth and to productivity is invariably found to be high in empirical studies. Actually, the estimated marginal productivity of infrastructure assets significantly exceeds that of non-infrastructure capital.[70] Hulten finds that differences in the effective use of infrastructure explain ¼ of the growth differential between Africa and East Asia, and more than 40% of the growth differential between fast and slow growing countries.[71] It has been calculated that, if the aggregate infrastructure stock of Ecuador or Colombia were to reach the level of South Korea, the growth rate of the economy would rise by 3 percentage points; if the infrastructure of Peru reached the level of Chile, Peru's growth rate would increase by 1.7 percentage points; if Indonesian telephone lines per capita were of the order of Japan, Indonesia's growth rate of would increase by 3 percentage points; if the power generating capacity of India were at the level of Israel or Hong Kong, the growth rate of income per capita in India would increase by 1.7 percentage points; if the railway density of Argentina were at the South Korean level, growth in Argentina would be 1.4 percentage points faster.[72]

This book does not suggest that these figures ought to be taken literally: They are only as good as the models and data employed permit. But they attribute an influence to infrastructure that other determinants seldom exhibit in similar cross-sections and, therefore, indicate that the build up of infrastructure must be given due consideration in any long-term growth strategy. A careful accumulation policy will take into account the social returns to marginal investments. These returns vary across the forms of investment: infrastructure and human capital. The share of each form in overall marginal investment should be weighted by its marginal social rate of return.

[69] See Aschauer, D., "Is Public Expenditure Productive?", Journal of Monetary Economics, No23, pp. 177-200.

[70] See Calderon, C., Easterly, W., and Serven, L., "Infrastructure in the Era of Macroeconomic Crises", in Easterly, W., and Serven, L., eds., The Limits of Stabilization: Infrastructure, Public Deficits and Growth in Latin America, Stanford University Press and the World Bank, 2003, pp. 21-94.

[71] See Hulten, C., "Infrastructure Capital and Economic Growth: How Well You Use It May Well Be More Important than How Much You Have", NBER Working Paper 5847, December 1996.

[72] Caldero, C., and Serven, L., "The Effects of Infrastructure Development on Growth and Income Distribution", Central Bank of Chile, Working Papers, No270, September 2004, pp; 15-17.

This is an important indication, in particular in countries that are struggling for, or are just achieving, stabilization. Fiscal austerity would usually be achieved at a disproportionate cost to infrastructure for the good reason that other items of public expenditures are socially too sensitive to take the brunt of the effort. Hence, many countries are under-capitalized in infrastructure. This may be due to a misunderstanding of the fiscal burden of infrastructure.

Financial markets do not fully finance infrastructure assets because their private rates of return are too low. It is then the responsibility of public authorities to implement them. Modern macroeconomic theory has established that structural public deficits are non-inflationary as long as they correspond to net public investment. The golden rule is that the discounted sum of returns (fewer expenses or more receipts) must cover the amount initially spent. Provided this rule is respected, the sky is the limit in the building of infrastructure (for other reasons the total public debt must, however, remain within a certain proportion of GDP and respect cyclical evolutions).

The problem, however, lies with estimating the discounted returns. In certain cases the problem is manageable. Tolls on highways, tariffs on electricity, and entrance fees to museums can be optimized as social utilities and demand previsions; the modernization cost of a public service can be compared to the anticipated productivity gains in delivering services. But new schools or new hospitals do not show clear gains or savings, and projects in new areas run risks that are difficult to anticipate (The tunnel under the Channel was built before high-tide terrorism arrived.).

But public infrastructure is limited not so much by fiscal technicalities as by the general withdrawal of the state required by the ideology of privatization that has reigned since the 80s. Given the difficulty of financing infrastructure from public sources alone, the private sector may be called upon to complete public efforts. Allowing the private sector to participate in the generation and operation of public goods presents regulation problems that have been discussed in the context of education policies. Principles to ensure second best guidelines for efficient regulation are available from industrial economics. They generally involve more competition in the provision of the public services. However, principles are not enough. It is their implementation that matters. Here it is vital that the regulators be well trained and kept immune from political interference.

4.1.3. Institutions and markets

4.1.3.1. Institutions

The role of institutions as important determinants of the business environment has become common knowledge since the Nobel Prize went to North and Fogel. The "rules of the game"

binding economic activities have repercussions on transaction costs. In fuzzy fiscal, legal or social circumstances, uncertainty grows and investments are hindered by risk premiums.

As was seen above in the case of International Property Rights, institutions are not good or bad in absolute terms but in relation to the local and international circumstances of society. The key to achieving a business environment conducive to productivity is to have institutions that adapt to the demographic and technological conditions of society. The coordinates of these conditions are positioned in relation to the distance of the economy in question from the world technological frontier. As the economy changes so should the institutions. But of course the dimensions of change are multifarious.

To label these dimensions in a catchall formula, one might perhaps say that the stability of the old order must give precedence to flexibility. In practice, this refers to a whole array of interactions between society and technology. For instance, start-ups and small-scale firms must be encouraged instead of the large incumbents of the market. Managers must be selected with the accent more on innovative talent than on reliable management of repetitive operations. Financial risks must be handled by a variety of specialized institutions, including venture capitalists, rather than left to the long-term cultivation of relationships between a bank and its clients. The factor markets must become more flexible. Furthermore, old policies have to be switched off and new ones switched on. For instance, public sector interventions must be re-oriented from mercantilist opportunities signalled by the markets to social welfare gains signalled by market imperfections.

The idea of a whole matrix of institutions shifting through time so as to ensure continuous optimization of the business environment under changing circumstances is daunting. In particular, it stumbles on the above-mentioned policy issue of time-consistency. Any program conceived today for the *ex ante* benefit of future generations could be repealed tomorrow if it lacks ex post political support.

Time-consistency is difficult to achieve even in the medium run. A fairly clear example of it has been delivered by the recent Argentine crisis. The Convertibility Plan adopted a sort of currency board that saved Argentina from hyperinflation. To conjure up faith in the durability of the plan, the government burned its boats. Agents were supposed to believe that since the government had ostensibly chosen to make it costly to abandon the plan, the plan would not be abandoned. Actually, when difficulties appeared, the agents interpreted the increased cost measures as a measure that had to be taken precisely because the plan was precarious. In the end the impact of the increased cost was to make the crisis worse when the plan failed.[73]

If time consistency is a problem in the medium run, a fortiori, it is a matter of concern in the long run when policies have to be sustained by successive generations of governments. A certain number of countries have managed to impart a great feeling of confidence in the

[73] See Kehoe, T., "What Can We Learn from the Current Crisis in Argentina?", Federal Reserve Bank of Minneapolis, Research Department Staff Report 318, July 2003.

continuity of their endeavour to ensure the right business environment by means of judicious adaptation of the institutions. South Korea, Singapore, Hong Kong, and Israel are examples that come to mind. Perhaps what these countries have in common is a sense that doing their best is a matter of life or death in the presence of adverse external circumstances. The case of Chile cannot be ascribed to external circumstances, though. In Chile political economy tribulations have been suppressed by a crushing victory of one camp over the other so that policies could be written in a non-contestable *tabula rasa*.

4.1.3.2. Markets

The role of well functioning markets on the efficiency of the economy has already been touched upon several times. In principle, markets should be as competitive and as exempt from regulation and barriers to entry as possible. In practice there will always be some regulation: regulation of goods, of firms (incumbents, entrants, or exiting), of international trade, and of the banking system. Since there will be regulation, it is desirable that the quality and integrity of the regulators be as high as possible.

The labour market

The imitation and adaptation phases demand as much identification as possible of the workers with the firm that employs them. With the advent of innovation, the usual prescription is, on the contrary, to foster a greater flexibility of the labour market. Flexibility means wage flexibility as well as labour mobility in the form of employment entry and exit. The good side of flexibility is improved productivity as labour is re-allocated to more productive jobs and as wage flexibility allows employment at wage rates that cannot be lowered. But there is a problem with flexibility in that it exposes the worker to the full brunt of the destructive creation process. The natural human quest for economic security, as a basis for the attainment of deeper goals (family, home, social participation), is threatened by flexibility. Hence, society must have an acceptable arrangement whereby risk sharing and productive efficiency are traded off. Put more simply, more flexibility for the worker should be supplemented by a social insurance scheme that is as efficient as possible (full efficiency is discarded because of the presence of moral hazard). An example of such a scheme might be found in Scandinavian countries.

The financial market

In the imitation and adaptation phase, the financing of investment is left to long-term relations between banks and clients. In times of innovation, the emphasis shifts from repetition to discovery. This is the moment for the non-monetary financial intermediation to take up the relay baton.

In the empirical literature, a deep financial intermediation (expressed, say, as the coefficient of private credit or, preferably, of financial assets in GDP) is empirically associated with an increase in the rate of growth and of TFP. Why is this so?

Under the key assumption of a perfect market, one could imagine a world in which the financial market does not matter at all as far as growth is concerned. Each investor would consider his wealth, the prices of products and inputs, the physical and human capital intensities of the available efficient techniques and the resulting productivity. This basis would be sufficient to decide whether to invest, in which technique to invest, and how much to invest. After some time, the investor would receive an income in return for his investment, would consume the part of this income that maximizes his utility function, and would re-invest the rest. In this setting, the invisible hand unfailingly stirs the right course of factor accumulation; intervention could only worsen, certainly not improve, the decisions taken by the economic agents. At the going rate of capital remuneration, anyone could borrow and lend as they wished. All good ideas about innovation or technology transfer could find financing, and the most laggard country would have no impediment to catching up with the technological frontier.

It is well known that the real world is not like that, and we saw in Chapter 2 that laggard countries fall further and further back. The difference between the imaginary and the real worlds is a set of distortions and market failures.

Take one of the main roles of the financial market, namely, its allocation role. It finds investment resources and brings them to efficient firms. This function is especially important when it comes to financing innovation or the implementation of technologies developed elsewhere, in other words, when it comes to financing something unprecedented in the country. Yet, even a first rate financial system would come up with first-best solutions. This is due to an agency problem created by the dissymmetry of information between lender and borrower, which allows the borrower to conceal the real likelihood of reimbursement of the loan. The lender will have to ration credit to borrowers with better guarantees; therefore, the given credit capability of the system will have to be shared among ideas with good guarantees, not, at the cost of efficiency, among good ideas. A smartly functioning financial system will need a lower guarantee threshold and, hence, will have to trade less good ideas against guaranteed ideas.

Take also the other important role of the financial system, its accumulation role. With the depth of the financial intermediation system, the credit multiplier in the economy increases. This credit multiplier defines the borrowing capacity of the country. It is not possible for a country to borrow all it wants but only what its credit capacity allows. A shallow system will have much more financing capacity than a deep system. Hence the quality of the financial system matters for growth. Furthermore, it is important that it can face instability, which has been seen to be adverse to growth. It takes liquid and well developed financial markets to allow firms and institutions to diversify and share risks arising from variations in financial prices like the exchange rate.

Actually, the quality of financial markets matters more for a country that is far away from the frontier because, as mentioned above, the cost of innovating or adapting increases with the distance from the frontier. Consequently, where the financial intermediation system is shallow, corrective interventions are a basic prescription to improve the business environment. Legislators and regulators should be careful to watch that financial systems remain free from political interference in the allocation of credit, lest loans are allocated on criteria other than economic merit. The result of allocation on political criteria may be under-investment (for instance, a Russian billionaire who is not certain of his property rights would buy a football club abroad rather than re-invest at home). The result may also be over-investment in less than optimal opportunities (for instance, by a clumsy entrepreneur who happens to be the nephew of the President).

The classical measures to deepen financial intermediation are lifting restrictions on credit allocation, getting rid of ceilings on interest rates, and freeing the banks from too harsh reserve requirements. At the same time that the system is liberalized, the authorities must become more competent in controlling it to ensure better regulation and supervision.

A comparison of the cases of Chile and Mexico sheds light on the consequences of ignoring this prescription. In the 1980s Chile and Mexico were both hit by a double external shock: an increase in the world interest rates, combined with a fall in the prices of copper and oil. Depression ensued in both countries, with TFP and output falling by more than 20%. The recoveries, however, were very different. This difference has been attributed to the way the authorities treated their financial intermediation systems after the crisis. In both cases the financial systems were nationalized but with very different purposes. In Chile, insolvent banks were liquidated and the solvent ones quickly re-privatized. To avoid mismanagement, a new regulatory scheme was set up. In Mexico, banks were bailed out, left under capitalized, and remained poorly managed. Unable to address the issue of the efficient allocation of resources, the government used the banking system to soften the immediate social losses provoked by the crisis. In particular, cheap loans were used to avoid firm closures.[74] Chile returned to trend in a decade. After 20 years Mexico still trailed about 30% under trend.

The international market

Integration into a wider market has been known, since Adam Smith, as an opportunity for a greater division of labour and, hence, for a higher productivity. The new growth theory added to this insight the view that openness to trade can also influence technological change. The stability and competitive weakness of the imitation economy is probably better served in a protected environment. It was actually the protected economies of the 50s to 80s that recorded

[74] See Bergoeing R., Kehoe P., Kehoe T., and Soto R., "A Decade Lost and Found: Mexico and Chile in the 1980s", Review of Economic Dynamics, vol. 5, January 2002a, pp. 166-205 and Tsounta, E.,"

Total Factor Productivity: The Victim of Job-Preserving Policies" University of Minnesota, Job Market Paper, December 2003.

the best growth rates. However, when the innovation phase comes, openness to trade must prevail. Openness to trade provides access to imported inputs, which embody new technology. The new technology increases the market size of producers (lower costs, new products). Larger markets, in turn, raise returns to innovation and lead to more country specialization in the generation and diffusion of technology. Furthermore, international trade forces domestic producers to be efficient in order to resist competition from foreign products.

The necessary transition, we now know, is delicate even when it is deserved. The example of Argentina recalled above bears witness to this. But premature transition might be disastrous. Taking a laggard economy, that would already be in crisis, and exposing it abruptly to the winds of globalization cannot be recommended.

4.2. A close-up on the micro level

Introduction

The framework of our inquiry has, up to now, been the whole economy. The level of the whole economy allows us a broad view and a deep understanding of the forces that might be at work. But these perspectives are inadequate for action, in particular for action by small international aid agencies. Moreover, the level of the whole economy may also be an unsatisfactory base for understanding productivity. In practice, productivity occurs in heterogeneous contexts. Productivity is an attribute of the productive system. In theory, the productive system of the whole economy is often represented by an aggregated production function, but in practice the productive system is comprised of various local production functions. Hence, in this section the focus shifts from the stylized facts of cross-country regressions to the micro foundations of the local productive system.

4.2.1. The conditions of the productive system in developing countries

It is a fact, observed in the global picture of Chapter 2, that TFP growth is slower in less developed countries. This is strange. Since developing countries are much less productive, they should have more opportunity to achieve large gains of productivity. Yet, this does not happen. The reason, in part, is that access to the frontier of technology is difficult, but that cannot be the whole story. In practically all developing countries, a handful of state-of-the-art firms found a way to sneak into the myriads of very backward firms. If some firms could do it, this means that the access to technology is not completely closed. Then, why can't the rest do it?

When it comes to countries lagging behind, it is a banal observation that domestic markets are small, that inputs must be imported, that human capital is scarce, that infrastructure is poor, and that financial markets are shallow. The macroeconomic fundamentals are volatile, and governance leaves much to be desired. Regulations are dense and pervasive: They touch upon

prices, trade, foreign exchange, tax, foreign and domestic investments, labour, and market entry. Combined, all these features impart to the productive system of developing countries its decisive characteristic, namely dualism with a high proportion of small plants. The United States has less than 3% of its people employed in establishments of less than 10 employees. Developing countries in general would have a 20 times larger proportion employed in that bracket. Moreover, a large number of micro enterprises hidden in the informal sector would still aggravate the imbalance. The coexistence of these contrasted worlds is probably to blame for the low average productivity of developing countries.

In a world without distortions, a good opportunity is as likely to be grabbed by a small firm (or a group of them) as by a large firm. But in a world full of market failures that discriminates between large and small firms, it is, on the contrary, likely that small firms would not have the incentive or the capability to go after a good opportunity even if they saw one.

A great source of information on productivity as it occurs in the real productive sector is the McKinsey Global Institute. These studies, summarized by Vincent Palmade, conclude that micro policy distortions within a country or between a country and the rest of the world have become the single most significant impediment to productivity.[75] There are plenty of distortions at industry level: restrictions on FDI, on licensing (which firm may have a license to do what), on prices, products and services, non-tariff trade barriers, and so on. There is bad management of quasi-natural monopolies, like telecommunications, telephone services, and oil supply, or of social services, like schools or hospitals. There are plenty of land market issues. But the worst of all problems is the unequal enforcement of policies between the formal and informal sectors and the inequality trap that ensues.

The verdict of the McKinsey Global Institute is clear. The informal sector is responsible for the productivity gap suffered by developing countries. Informal companies operate fully or partially outside the formal fiscal and legal environment. They tend to be sub-scale, sub-invested and sub-skilled. They also tend to produce sub-standard goods and services. To meet the international requirements of globalization, governments keep raising taxes on formal firms. This places the informal sector in a relatively advantageous position and therefore re-enforces informality. In its country studies, the McKinsey Institute estimated that informality was costing developing countries between one and two percentage points in annual GDP growth.

[75] See Palmade, V., "Industry level analysis: the way to identify the binding constraints to economic growth", World Bank Policy Research Working Paper 3551, March 2005, pp. 1-32.

Box 5: Brazil's Informal Labour Market

One of the main issues related to the development of a productive labour supply in Brazil is the fact that a large part of the labour force is informal, creating a sizeable shadow economy. A recent study argues forcefully that informal labour is a powerful obstacle to productivity growth in Brazil (McKinsey & Company, 2004).[76]

The McKinsey study defines informality as the performance of licit activities in irregular forms through non-compliance with regulations (evasion of taxes and duties and falsifications of instruments of fiscal control; non-payment of social security, non-existence of wage legislation and undeclared employment in labour markets; and evasion of requirements on product quality, property rights, environment, etc. in product market regulations) that imply substantial hidden costs to the economy.[77] The costs associated with compliance with existing law are an inducement to less competitive firms to turn to informality as a strategy for survival.

Formal firms in Brazil are estimated to be about 50% more productive than informal ones. This is due to the difficulty that informal firms have in accessing financial market mechanisms, in accessing the judiciary in order to enforce contracts, and to their disincentive to grow due to fears of being caught by the government agencies in charge of enforcing tax and other legal norms and procedures.

Once they have turned informal, there is little incentive for firms to invest in physical and human capital. Access to credit markets becomes more difficult. They have no incentive to grow because they would become more visible if they did. Their business relationships tend to be with other informal firms. McKinsey (2004) concluded that increasing the formal economy relative to the informal, or shadow economy, would have an important impact on Brazil's GDP and productivity. Thus, for instance, the informal sector's lower use of capital relative to labour—a typical feature of informal activities, and one often associated with lower productivity levels—follows from the tax evasion of labour costs. These and other barriers to formal economic activities are powerful impediments to productivity growth.

From the McKinsey (2004) report we also learn that informal labour activities were approximately constant in 1992-2002 (56.6% of the employed population in 1992 and 55.0% in 2002). Informality was nearly stable only because agriculture's share in total employment had decreased. In fact, from the Brazilian household surveys (PNAD) we learn that the share of informal labour in agriculture is estimated at 90% (91.5% in 1992 and 89.9% in 2002). Figures for the remaining sectors are: manufacturing industries, 26.9% and 37.1 %, in 1992 and 2002 respectively; construction, 61.3% and 71.1%; commerce, 43.9% and 53.3%; transportation and communications, 28.5% and 42.0%; public administration and social services, 20.8% and 17.7%; and other services, 58.8% and 56.0%. Therefore, in the non-farm sector, as a whole, informal labour increased from 42.9% of the employed population in 1992 to 46.0% in 2002. This reflects migration from rural to urban areas, as will be further explored below. As to the within-manufacturing sector composition of informal labour activities, the report states that it is concentrated in sectors such as clothing and accessories (where 62% of employment is informal),[78] textiles (56%), food products and beverages (40%), and metal products (38%).

[76] See McKinsey & Company (2004) *Eliminado as Barreiras ao Crescimento Econômico e à Economia Formal no Brasil*, São Paulo, SP, Brasil. Informal labour relations are tolerated because of the social implications of high unemployment: it is better for the poor to have some income, even if earned in the shadow economy, than to have none. Therefore, there is a cultural perception that a certain degree of informality is tolerable and, indeed, acceptable. But the implications for productivity advances incorporated in these activities should not be overlooked.

[77] Drug trafficking, prostitution and gambling are (obviously) not included in their definition of informal activities.

[78] Defined as non-contributing to the social security system.

Informality in Brazil has several causes, the most important being: (i) high costs implied by formalization; these can be divided into those arising from rigid rules such as the ones for creating and closing down businesses,[79] and those governing labour relations[80] (see below); and an excessive tax burden on formal firms and contributions to social security; [81] and (ii) low enforcement capacity on the part of the authorities, often associated with a slow judiciary and a disproportionate judiciary burden.[82]

McKinsey (2004) concludes by presenting estimates of the output and productivity gains that could be achieved through decreasing informality. After fitting an equation to data on productivity growth rates and informality rates in 26 manufacturing industries, a significant and strongly negative association was found. The equation results were then used to predict productivity growth in 1996-2001 under two assumptions on informality reduction (20% and 40%) in all sectors, simultaneously. Manufacturing output would then increase by an additional percentage of between 1.5% and 3.0%. Labour productivity would be increased from an observed 1.4% p.a. to 2.8% or 4.6% p.a., depending on the informality reduction achieved. The study also suggests that for the economy as a whole the additional productivity increase would be on the order of 1.5% p.a., which is a rather powerful effect.

It is difficult to follow the McKinsey Institute radically. Distortions are responsible for an inefficient allocation of resources in the economy; that much is uncontroversial. But the inefficient allocation is not always to the detriment of large firms and to the advantage of small firms. Distortions sometimes place too many resources in large enterprises, as in the case of the badly managed quasi-natural monopolies, and sometimes they place too few resources in the hands of small firms. If two firms, a large one and a small one, see exactly the same investment opportunity, the chances are that the large one will set up an ultra modern facility whereas the small one will have to be content with a backward plant. This outcome would be all right if both firms got what they deserved in terms of their respective merits. But the outcome may be due to the fact that the small firm could not obtain a loan (for instance, because monitoring loans to small firms is too costly) and therefore had to settle for an inefficient plant. In certain countries, of which India and Mexico could be instances, distortions tend to be more in favour of small firms. In others, the reverse holds true.

[79] The World Bank (2004) document states that it takes, on average, 152 days to establish a business in Brazil. The average closing down period is 10 years.

[80] From the World Bank (2004) document we learned that Brazil has the third least flexible labour legislation in the world.

[81] Of the tax rate of 34.1% of GDP collected in 2001, 11.0% came from employer social security contributions and 12.1% from indirect taxes. Mc Kinsey (p. 28, 2004).

[82] Anecdotal evidence: while in Brazil the Supreme Court examines some 164,000 processes each year, the Supreme Court in the USA issues sentences on approximately 100 cases per annum, only.

4.2.2. Productivity in the plants

Introduction

How close can one go to look at productivity? Harberger introduced two visions of the growth process.[83] One is based on an analogy with yeast that "causes bread to expand very evenly, like a balloon being filled with air". The other is with mushrooms that "have the habit of popping up, almost overnight, in a fashion that is not easy to predict". When considered at the sector level, productivity growth looks like the mushrooms. The mushroom style of productivity manifestation means that the cause of productivity is very local indeed.

And actually, it seems to be so. No matter the level of aggregation of the productive system one considers – the sectors, the industrial branches, the sub-branches, and the firms – the degree of heterogeneity observed does not decrease. In an economy with rapid productivity gains there will always be sectors with a low or negative productivity growth rate; in a sector with high growth rates there will always be branches with low or negative growth rates; in a branch with high growth rate there will always be sub-branches with low or negative growth rates; and so on. This is, of course quite a distant vision from that delivered at the macroeconomic level, where the endogenous growth theory had us seeing externalities and scale exerting effects on the economy as a whole.

When technological change occurs, it affects the elements of the productive system according to their respective production functions. The smallest level of a production function that standard observation methods can approach is the statistical unit of industrial statistics, i.e., the plant level. It is therefore at the plant level that the causes of productivity will now be explored.

4.2.2.1. Plant-level analysis

Statistical surveys of industry typically encompass thousands of statistical units (firms or their establishments). The data compiled are aggregated over interesting categories of statistical units (firms of certain sizes; firms located in certain regions; firms in certain industrial branches; and so forth). Using aggregates instead of plant-level data has the induced effect of supporting the view of a representative plant. As the data are aggregated, one tends to presume that all plants in the category considered (say the manufacturing sector, the industry, the region, or the size class) share the same technique, the same production function, the same size; in sum, that all the plants included in the category can be represented by a single plant. Fortunately, another approach is possible. We can now use the micro-data to identify plants uniquely across adjacent years; hence, we can construct time series of variables that are specific to individual plants. Using this

[83] See Harberger, op. cit., p. 4.

possibility of a close up at plant level, a certain number of aspects of productivity can be better seen.[84]

Dynamic patterns of plant entry growth and exit

- Entering and exiting firms are smaller than incumbent producers: the size of the end result is from 25% to 40% of the size of incumbents (the same as in industrial countries). Noteworthy here is that size is not necessarily an intrinsic condition but can be a transient state in a trajectory to a large scale.

- Rates of entry and exit are relatively high, at 10%. This is more than in developed countries, where they are 7%. It is also more than a simple adjustment of the number of plants to fluctuation of demand. It is a turbulence that reflects a continual replacement of incumbent producers by newcomers. This finding refutes the preconception that a combination of small markets, scale economies, and institutional problems (lack of credit, cronyism, and protection) is responsible for a rigid incumbency of producers. On the contrary, the population of producers is quite fluid.

- It was Marshall, some 80 years ago, who intuited that independent new small firms could be seen as the seedbed for new enterprises capable of challenging established businesses. From there it has been argued that special care should be taken of the seedbed. But turbulence is so strong that there does not seem to be a concern that the fertile undergrowth may erode if left unattended by government assistance.

What happens after entry?

- The failure rate decreases as plants age: between 20% - 30% in the first year, to 13 -15% in the third year, as in industrial countries. This means that most entrants have very short lives (less than half will make it to 5 years).

- The market share of new entrants is small and declines consistently in each year following entry. Over time, the output of a cohort of entrants tends to fall, because the loss of output from exiting producers is greater than the gain in output from survivors that are growing.

- In general, the average size of each cohort's surviving plants relative to the average size of all plants increases as the cohort ages. This can be due both to the growth of surviving plants and to the relative smallness of the exiting plants. Hence, the increasing average size is not a sure indication of the growth of the survivor. It remains the case that turbulence increases the average scale.

[84] See Mead and Liedholm, World Development, vol. 26, No1, 1998. and Roberts and Tybout ed., Industrial Evolution in Developing Countries, Oxford University Press, 1996).

- Exceptions are observed: It may be that new cohorts, are immune, for some reason, to inhibiting factors that burden the older ones (for instance, financial problems), and grow fast enough to expand their market share relative to that of older cohorts. This should draw our attention to the question of the macroeconomic context.

- In sum, the notion that new firms typically grow to become significant producers does not match the patterns found. The sustainability of aid is hereby questioned.

Employment flows

By summing plant employment over entering, exiting and surviving plants, it is possible to observe some interesting regularities.

- The overall changes in employment are not very marked (-1, + 1%/year; 6.5 % in the main exceptional case).

- Behind this tranquillity lies a great deal of micro-level turbulence (with rates between 19 and 30%: The gross flows of jobs are many times larger than the net change in employment).

- The net change in employment is cyclical: positive in boom periods, negative in recession years. However, there are large flows of new jobs, even during periods of overall manufacturing contraction, and large flows of job losses during periods of substantial growth.

Productivity

By following plant-specific productivity trajectories for all plants in an industry, industry-wide productivity growth can be decomposed into the effect of interplant efficiency changes, market share reallocations among plants with different levels of efficiency, and changes in the population of plants.

- Net entry and exit are important in explaining productivity dynamics, but the patterns are quite diverse. During the recession of the 1980s in Chile, net exit increased the market share of incumbents, improving aggregate productivity. Net entry did the opposite in Morocco, where micro-economic expansion was associated with rapid net entry, falling market shares for incumbents and lower aggregate productivity. Small young plants tend to be less productive on average and they make up the bulk of both entries and exits;

- Exiting plants tend to be less productive than the entering plants but the difference is small.

- The productivity of young cohorts rises as they mature, reflecting the combined effects of weak plants dropping out and surviving plants improving.

- Some years before exit, exiting plants typically enter into a downward spiral – "the shadow of death" – suggesting that they would only get worse if they were to hang around. As new plants mature their weighted average productivity rises rapidly: One-year-old and two-year-old plants are nearly as unproductive as exiting plants, but plants that survive to be four-year-olds match or exceed industry sources.

- In the short run, the replacement of dying plants with entering plants does not create dramatic changes, since neither type of plant is very efficient on average, and neither accounts for a large market share. But dying plants become progressively less productive in their final years while new plants that survive improve rapidly. As a result, policies that inhibit this replacement process probably have substantial medium and long-term detrimental effects on productivity.

- The productivity gains from turnover are not cost-free. Moving resources has a cost: Income is lost where factors are idled in the process.

- What happens when a shock – say an increase in the cost of capital to investors – occurs?[85] After two to four years, the creation of jobs falls in most industries whereas destruction rates increase, and the re-allocation of jobs across plants slows down. Hence, there seems to be a sizable negative effect on the marginal cost of creating jobs. Capital-intensive firms depending on bank credit are the most affected.

- If the shock is, for instance, on non-wage labour cost, the response will be felt only on the destruction side. There will be an increase in job destruction until about the sixth quarter after the shock, but there will be no impact on job creation. A decrease in non-wage labour cost would have the inverse effect of slowing down job destruction and the same lack of impact on job creation. Labour-intensive industries are best placed to take advantage of a reduction in this type of cost.

Policy implications

The findings are consistent with the view that recessions are times of cleansing the production structure as employers close or scale back inefficient plants. Since small plants grow faster than large ones, it has been argued that, in proportional terms, employment grows faster in small plants than in large ones. In absolute numbers, expansions and contractions in continuing plants are the major source of turbulence in overall employment. Considering that the expansion of existing businesses creates more jobs than start-ups and that the majority of start-ups do not

[85] See Sanchez, G., and Butler, I., "Market Institutions, Labor Market Dynamics and Productivity in Argentina during the 1990s", Fundacion Mediterranea, 2005.

survive four years, doubts rise about the potential effectiveness of development policies focusing on attracting new business establishments and in preventing business failures. Policies designed to encourage the establishment of new plants may simply elevate the level of small plant failure. On the contrary, policies designed to encourage existing businesses seem more attractive. If they are successful, there is a much lower risk of the employment gain being only temporary. However, high small-business exit rates are often accompanied by high small-business formation rates. Thus, the jobs lost by failing small businesses may simply elevate the rate of small plant failure. In both expansionary and contraction periods, plant entry and exit are responsible for a larger proportion of total turnovers in developing countries.

Given the within-industry heterogeneity, exit-preventing policies run the risk of slowing the process by which inefficient producers are replaced by more efficient ones. It has been shown by simulation that an increase in mandated severance payments to laid-off workers actually reduces employment and labour productivity by distorting the turnover process.

In general, the empirical correlations are negative: In recessions, there is job cleansing but not job creation. There is, therefore, room for a policy that translates turnover into benefits such as the productivity gain from replacing inefficient with efficient producers and saves costs such as long spells of unemployment. Of particular interest for policy is whether the selection process successfully spots and rewards the more efficient, more productive plants.

4.2.2.2. Cross-country variables

Cross-country regressions tend to identify certain variables, for example, openness variables, such as trade liberalization or foreign direct investment – or domestic technology – as potentially pro-productivity. In what follows, it is proposed that the validity of the cross-country view be checked by glancing at facts found by a flurry of empirical studies that have used plant-level analysis in the context of developing countries. These facts were compiled and assessed by Tybout in a paper on which the following text relies heavily.[86]

Productivity levels and trade liberalization

Often it has been observed that, when trade barriers go down, productivity levels take higher average values and become more uniform across manufacturing firms. Why this is so remains unclear. Internal scale effects of import penetration have been considered possible culprits, but no evidence could be mustered. Yet, when imports are allowed to enter, the average size of domestic firms is cut down; but it is almost always observed that the reductions are in large plants. These plants cut size in the constant return range of their cost curves and productivity is, therefore, not changed by these reductions.

[86] See Tybout, J., "Manufacturing Firms in Developing Countries: How well do they do, and why?", August 28, 1998, mimeo.

External scale effects have also been looked at as possible explanatory factors, and some effects are detected in some studies, but these are indeed very small. In sum, at the present stage of our knowledge, we are can only suppose that when trade liberalization increases productivity it is due not to scale effects, internal or external, but to a fight against X-inefficiency within firms, because of better access to foreign inputs or because of more incentives to best practice.

Productivity growth and trade liberalization

In general, it is difficult to get evidence capable of discriminating between a one-off adjustment that manages a transition from one level to another level of productivity from a durable change in the growth rate of productivity. But there are two streams of evidence-based studies that have tried to approach this problem.

The first stream looks at the interactions that occur when technology is transferred through imports, as when imports are de-engineered by the recipient countries, or when imported innovative capital or intermediate goods are deployed. All that this stream of studies found was that imported capital and intermediate goods are an important channel, perhaps the most important, for technology diffusion. There is, however, no evidence to tell how important it is.

The second stream looks at technology acquisition through exporting. The contacts gained through exporting may be the way to new technologies: Management techniques and product designs are learned from foreign buyers. This stream established fairly well that firms that export have better productivity than others in the same industry or the same country.

Can it be said that there is a learning-by-exporting effect so that firms become better because they export, or is it that the best firms are the ones that manage to export? Here the evidence goes more towards the second possibility. The results are, in general, that the exporters of today were already more efficient than non-exporters before they started to export. Furthermore, in most industries the productivity gap between exporters and non-exporters does not tend to grow over time, as the learning-by-exporting idea would suggest. Yet, in several industries there are firms that do become more productive after becoming exporters. Hence, the learning-by-exporting hypothesis cannot be completely discarded. One of the authors of this book studied the evidence from Kenyan plant-level data and found just that. Efficient firms self-select into exports but there is some evidence in favour of learning from exports.

Even when exporting does not improve the productivity of exporters, it may improve the productivity of non-exporters, possibly through agglomeration effects. When many firms in an agglomeration have been exporting, the firms in that agglomeration, even the non-exporting ones, tend to have lower average costs. This may be due to spillovers (demonstration effects, skilled worker training, or education of the local suppliers), but the possibility cannot be dismissed that the agglomeration simply sits on a region with advantages in materials or cheap labour.

On the whole, trade liberalization increases productivity. This is due to foreign competition that forces domestic producers to exit the market or reduce size, and to additional export opportunities for efficient exporters. The less efficient plants are those that are put out of business or scaled down. The scale of productivity-increase depends upon the resistance strength of those bound to lose in the destructive creation process. When unions are strong they can mitigate capital destruction and job losses. The result is more employment in the short run and less productivity growth in the long run. The net welfare result depends on a comparison between the benefits of higher productivity and the costs of factor (capital and labour) redeployment and destruction.

Trade liberalization can be accompanied either by appreciation or depreciation of the real rate of exchange of the currency. Appreciation of the local currency means tougher competition for local producers. A loss of market share yields lower labour demand. But the imported inputs become less costly, thereby enticing more investment and more demand for jobs. The first effect is more important than the second in countries that depend on imports of machinery and equipments for capital formation.

Domestic knowledge generation and productivity growth

In developing countries, R&D goes more towards adapting foreign technology to local circumstances than to generating new technology. Adaptation efforts cannot be measured by outcomes, like patents for instance; they need to be measured through inputs. The presence of engineers, technicians and scientists (ETS) in the personnel of a firm is the usual proxy to measure adaptation efforts in developing-country firms.

Is it the case that ETS firms tend to record faster productivity growth than other firms in the country? What can be observed is that ETS-intensive firms do have higher productivity levels, but do not tend to have higher productivity growth than other firms.

4.2.2.3. Conclusion

The evidence gathered in the thirty or forty studies on which the above is based suggests that individual variables are poorly explicative of productivity performance. Instead, at least two studies suggest that what is good for productivity is a combination of exports, domestic learning-by-doing, and access to international technology.

Chapter 5: Policy conclusions

5.1. A policy framework

The world stock of useable production knowledge grows over time. More efficient production techniques enter the scene; less efficient techniques become obsolete; best practices are continuously popping up. These new production possibilities are, in principle, accessible and it is vital for the growth and welfare of the world that developing countries take advantage of them. In practice, however, this takes place only in a very uneven way. The individual performance of a country depends not only on the country itself but also on the worldwide innovation rate. The world technological frontier shifts and this creates ever more difficult conditions for laggard countries. A glaring symptom that something has gone wrong is displayed in the thousands of workers who undergo appalling suffering to move to foreign environments where productivity is 5 or 10 times higher than in their home countries. Things must go the other way; it is not people that must cross borders to find productivity but productivity that must be brought where it is glaringly missing.

Yet, it is very hard to bring productivity to developing countries.

What must be brought in the first place is technology. Technology is partly a public good; it is not easy to accumulate enough of a public good because those who pay for it are fewer than those who use it. Hence, public intervention to stimulate the transfer of technology is justified. These interventions have two targets in their sights. Since technology is knowledge about how to do things, the first target will be located on the knowledge (the logos) side of technology. The question here is how to influence the process whereby intellectual capital is acquired, generated and used. Free markets are of little use in regulating this process because of the non-rivalry attribute of knowledge. Instead, the patent system and science, exposed to the scepticism of peers, are to be in charge of generating knowledge and distributing it.

The second target derives from the fact that knowledge by itself cannot do anything to stir productivity. It is only when knowledge meets matter (the "techne" side of technology), when it gives birth to better modes of organization, better processes, better equipments, better labour skills, better products, better supplier relations, and so forth, that productivity is enhanced. The second target is the process whereby technology is embodied in the production system.

In both areas, externalities and imperfect competition have been found to play a major role. It ensues that the free play of market forces cannot deliver proper incentives to accumulate technology. Market forces should play a role, certainly, but the requirements of social welfare have to be delivered by policies, and these policies must be about the generation of incentives leading to socially efficient outcomes.

Both knowledge acquisition and its implementation in the form of activities that put new techniques to use can be pursued by long-term supply policies. The three sails that will propel

productivity (if the wind blows) are the National Innovation System, the education system, and the communication and energy infrastructure.

Expenditures made in these three areas are going to be expenditures diverted from direct production. The major policy problem in matters of technology generation is to find the right proportion between expenditures made on the three sails of technology and those made on activities devoted to production. We know that this proportion will have to change according to the current level of technology of the country. This is because the cost of enhancing domestic technology decreases with the current technological level. As the country climbs the ladder of imitation-adaptation-differentiation-innovation, the part spent on technology expenditures should increase.

A provider of public goods that can be most readily identified with a productivity sail is a National Innovation System. Ideally, the National Innovation System would link investigation – not only institutes and specialized laboratories, but also universities – to industries and reach as far as the small firms. It would be oriented towards technological projects based on national comparative advantages – often in the field of natural resources – and address non-excludable areas so as to benefit collectively all those involved in the area (the case of oenological projects in Chile). The characteristics of this system would necessarily be context-based and should therefore change according to the changing level of productivity achieved in the country in question.

The public good that serves as the second sail is education. It is no longer a specialized sail – education, obviously, is the source of both the technology and the production labour forces – yet it is a vital one. Every country is recommended to take pro-active measures to achieve 100% enrolment in the primary level of education and to develop kindergarten schooling. When it comes to enrolment in the secondary and tertiary levels, a country should be swiftly reactive. Thus, as far as growth is concerned (but it is acknowledged that growth is not the only consideration when it comes to the value of education), the optimal education expenditures would be defined in amount and in structure in accordance with the level of productivity of the country. It would be focused on the secondary level as long as the country does not pass the adaptation stage. The focus would move on to the tertiary level when the differentiation stage is reached.

What really matters more than quantity in the field of education, though, is quality. In this, the existing systems are very often deficient. There are alternative ways to improve these systems, but they are difficult to implement, given that education is deeply anchored in society, a large part of which may be expected to drag its feet when reforms come. As education is a large-scale system it can be reformed effectively only under a very strict governance system where social objectives, efficiency considerations and transparency are critical.

The third sail is infrastructure. This one is more directly linked to production, and not so much to technology, but, through its impact on production costs, it is one of the most important determinants of productivity. Our thinking concerning infrastructure is in tune with the new

fiscal theory of the price level that makes an explicit link between the level of public debt (with respect to current public receipts) and the general price level. In the frame of this theory, the growth of public debt either does not generate inflation (current prices having already overtaken the threshold corresponding to the debt level), or it generates inflation only for debt increments not linked to future receipts. From there, one may conclude that expenditures on productive investments are in harmony with serious stability concerns.

Moreover, the risks of coordination failure are known to be very general in economies with rigid prices or salaries. In economies where certain prices cannot be lowered for good social reasons (say a threshold under which reservation wages are not permitted to decrease in order to maintain a certain distribution of income), there is a continuum of equilibriums (a situation from which there is no incentive to depart) in situations where the resources with rigid prices are severely underused. There would be an obvious welfare gain in making more use of the underused resources. Hence there is an argument for a demand policy led by expenditures on productive investments.

Combined, the two arguments (non-inflationary spending and demand policy) above recommend, at least in countries with unutilized resources, a vigorous (say about 1% of GDP in adaptation economies) infrastructure policy for expenditures on things like energy, urban transportation and social housing.

Possessing the three sails is a critical condition for productivity, but all it does is to provide a potential to catch the wind of opportunities. The actual utilization of that potential may vary to a rather large extent according to the skills with which these sails are deployed. To get close to full utilization requires the fine-tuning of a host of factors to the developmental context of the country. The economy will be receptive to productivity only if all these factors are present and if they are activated by the right incentives. It is here that the really hard work begins because productivity flourishes only in propitious environments whereas the real world is not naturally a propitious environment for productivity.

It is a world where information is very often imperfect (for instance, banks have less risk information than the small firms that need credit); where markets are often incomplete (there is, for instance, no market where students can borrow on their future earnings); and where the markets are distorted by all kind of interventions (for instance, new firms cannot enter markets without jumping over barriers; incumbent firms are submitted to all kinds of regulations; or substandard firms are not left to fail).

Externalities, imperfect competition, imperfect information, and market incompleteness demand policy interventions; distortions need to be minimized. These are jobs that require artful performers. The policy interventions contemplated are, in most cases, of a macroeconomic order. But modern macroeconomics wants to rest on rigorous microeconomic fundamentals. This means that the macroeconomic solutions adopted must be based on decisions that will be taken in their own spheres by agents and decision makers of all sorts (government, local authorities, central banks, trade unions, firms). The art of pro-productivity policies is to elicit

the right ingredients and to mix them so as to serve the economy a cocktail on which it would not want to pass. The performers of this art are the state and the civil society, in the right proportions: the state in the guise of regulators and the civil society as a guarantor of transparency. The policies are discussed individually in Chapter 4. What can be said, in general, of the characteristics of policies that should be inscribed in this framework?

First, achieving the objective of maximum productivity demands the intervention of a whole array of instruments directed at a large range of targets. There are allocation policies to set the right shares between R&D, education, and infrastructure; stabilization policies to minimize macroeconomic shocks; re-distribution policies to support the demand of education; micro policies to suppress market distortions. Some policies are long-term; others are medium-term.

Second, these policies are interrelated and, therefore, can be contradictory or, on the contrary, mutually re-enforcing. A recession may have an anti-productivity effect in the short-term but a pro-productivity effect in the long term. Expenditures on public infrastructure are pro-productivity but take resources away from education expenditures that are also pro-productivity. Furthermore, any policy may have a positive effect on some target groups and a negative effect on others. Trade liberalization favours some firms and some workers but is unfavourable to others.

Third, the policy decisions are taken in the context of societies where political interactions may keep ideal economic solutions out of reach either because the ideal cannot be defined or because it cannot be implemented.

Fourth, there may be no ideal economic solutions but only second best solutions as when moral hazards interfere with first best re-distribution of risks, or when asymmetric information conceals the real range of choices of some agents.

Fifth, policies are subject to the passage of time. There is, therefore, a time consistency problem: The decisions taken by agents and decision makers must, of necessity, take into consideration their outcomes, immediate or delayed. A policy will provide an incentive to agents only to the extent that the circumstances under which it was accepted will not change too much. Hence, the concern for time consistency is central in plumbing the macroeconomic consequences of microeconomic decisions.

Sixth, the ideal cocktail of policies is conditional upon the distance of the country from the world technological frontier. The objective of the cocktail is to move the country closer to the frontier. In other words, as the country goes on taking the cocktail, the cocktail must change.

Given all these characteristics, it is clear that the maximization of productivity performance will take more than a collection of policy measures. What is needed, instead, is a framework within which an array of policies will shift according to the distance from the objective, while maintaining consistency and convergence towards that objective.

The custodian under which continuity can be assumed to underpin change is a set-up of institutions that show evidence of their benevolence and competence in policy making.

5.2 Monitoring and evaluating

Who is going to keep custody of this custodian? Transparency is the guardian of ultimate recourse. In the Netherlands the Centraal Planbureau uses its economic models to examine the economic programs of rival parties before the election and makes an *ex post* evaluation of the results achieved. Questions of methodology and impartiality may render this formula impractical anywhere else than in the Netherlands, but this book recommends the use of monitoring and evaluation as watchdogs of the policy-making process. Monitoring and evaluation technologies have made considerable progress recently, to the certain benefit of the productivity of adopters.

Monitoring

One policy principle strongly advocated is to liberalize markets. The other side of this coin is to decentralize economic decision-making. The state can no longer hold the monopoly on decision-making. It is true that much has already been done in that direction in the course of the forty years under review, but in several areas, like R&D policy, education and health policies, public utilities policy, and so on, more decentralization appears advisable.

On the subject of decentralization, the financial collapse of Argentina is there to remind us of the vital need to produce a national scheme clarifying the responsibilities of each level of government. All the elements involved, including the citizenry, should understand spending assignments across government levels. Overlaps should be avoided and reliance on federal funds clearly delimitated. The idea is to give to autonomous entities the power to decide, with respect for the general welfare and within the confines of a precise mandate, but without Government interventions.

Of course all entities must be responsible and accountable for their actions. Here arises a problem of asymmetry of information. When autonomy is given to the agent of a policy, the agent develops better information on the domain under its aegis than does the state. How can the state then control and check that the general welfare is well served? In health, water supply, education, telecommunications, the state, or provincial or local authorities, extend contracts to private operators. These operators know more than their counterparts about the technologies, the consumer habits or pathologies, the condition of infrastructure, the operating costs, etc. They are then in a position to use their information advantage to extract a rent from their counterparts and ultimately reduce the general welfare. A certain loss of welfare cannot be avoided in conditions of limited information, but there are instruments available to minimize this loss. For instance, the state can stipulate contracts that induce agents to reveal part of the information at their disposal. If the contracted activity involves random risks, the contract must entice the firm to

reveal them (otherwise quality would suffer) without exaggerating them. One technique to obtain at least a partial revelation is to propose a range of contracts designed in such a way that the bidding firms will reveal cost information through the preference they exhibit with respect to the contracts offered (basically, across the range, subventions are paid according to a convex and decreasing function of production costs). The most efficient firms bid for a larger portion of the costs (because these firms know that in their case the costs will be low) whereas less efficient firms will try to leave as much of the costs as possible to the state.

Evaluation

No intervention program should be allowed to fail completely. This holds true in all fields of intervention: R&D, human capital, support to SMEs, and so on. To monitor a given program, an evaluation system must be mounted from the very beginning, which is capable of comparing a particular impact on the existing situation to the outcome that was expected. To be incorporated in the intervention program, any component must make the demonstration, or, at least, establish the plausible assumption, that it will be causal (if x, then y) in generating the expected outcome, and must dispel alternative scenarios suggesting that the causality would not work. The logical model specifying the sequence of causal actions is then submitted to testing, both in the target and in control groups. To do that, a set of indicators must be designed (not an instantaneous operation since the indicators must be selected so as to be relevant to the intended measurements; they should be an accurate surrogate of the reality to be measured; should be practical; and should be as immune as possible from measurement errors) and the data must be collected from the inception of the operational existence of the intervention both in target and in control groups. This method is the only one that allows separating deadwood (effects that would have obtained anyway without the intervention program) from the actual impact of the intervention program.

5.3. Scope for UNIDO's action

From all the preceding, it is clear that the scope of action for UNIDO must be approached in relation to the current level of productivity of the countries in which intervention is to occur, and, in particular to the distance between the technology level of the country and the world technological frontier.

UNIDO's domain of action comprises a large number of countries located close to the origins of the technological space: countries that are not only at a low technological level but are also distant from their relevant frontier rim. UNIDO's principal role, in matters of productivity, is to help these countries close the efficiency gap that prevents them achieving their potential productivity performance. Its secondary role is to bring to them the incremental shifts of the technological set. And while productivity must be fostered, even at this low technological level, the growth of these countries depends principally upon accumulation. But their accumulation

phase goes together with the TFP phase that will ensue. Hence it can be said that working on accumulation today is tantamount to working on the productivity phase of tomorrow.

The micro foundations of sector conditions seem to be the locus of productivity determinants. It is the area that UNIDO and other international organizations ought to take as targets of study and intervention. With both these purposes in mind, UNIDO has prepared a certain number of intervention instruments. These instruments are modulated in a function of the development level of the recipient country.

First, there are a small number of countries whose productivity levels and per capita incomes place them in a sphere of action where technological change is the prominent variable. For these countries, we provide things like Technology Foresight or Certification Centres (that signal quality to promote exports).

Second, there are many developing countries that are left behind, worse, that are falling further behind the small minority of winners. In this case, globalisation basically means heightened exposure to external risk. A social insurance against this risk will not come from mere static efficiency cum trade liberalization. Economic welfare will have to come from explicit developmental actions such as building industrial and technological capabilities, furthering improved governance, networking, and stimulating entrepreneurship. The principle that orients our action is to provide public goods (Magariños et al, 2001) that compensate, partly of course, for the under-provision by the market of what is socially desirable in the fight against poverty. Here, we are addressing countries that are not concerned with pushing the world technological frontier but rather with taking a position in their corresponding edge of this frontier. The role of UNIDO lies not so much in helping them to make the technological shift, but in helping them gain efficiency – hence productivity – within the existing technological set.

For these countries we do things like agro-business. The farm sector looms large in the economy-wide performance of low-income countries, where agriculture tends to be the dominant employer and farmland provides a large fraction of the capital stock. Thus, agricultural productivity growth happens to be a major determinant of per capita growth. UNIDO does not deal with agriculture, that is the domain of FAO, but it deals with the manufacturing firms connected to agriculture as suppliers of inputs to farms and as buyers of inputs from farms. These firms are responsible for a great deal of the R&D expenditures oriented towards excludable usages in agriculture (excludable usages are those where the spender of R&D can ensure that he will be able to recoup the dividend of his investment because he can claim the property rights to the resulting innovation; non-excludable usages, like the genes embodied in open-pollinated crops, are not financed by private R&D). In Africa, R&D spent on agricultural usages accounts for a good portion of agricultural output growth, hence of per capita income growth. But private firms do not consider the social welfare impact in their expenditure plans. Thus, a selective programme of assistance designed to support the manufacturing firms that contribute to agricultural R&D expenditures is seen as a public good. In low-income countries an inordinate portion of firms take shelter in the informal sector to escape from the red-tape waiting for them in the formal sector. The drawback of this low-profile

strategy is that it restricts their access to resources, in particular, financial resources. Informal firms, where large numbers of the workforce are concentrated, are then exposed to higher risks because of an asymmetry of information concerning their real performance potential. This situation feeds informality and exercises a drag on productivity. In the hope of modifying it, UNIDO deploys information networks at the service of the small-firms, in particular those in the informal sector. The idea is to use the Internet to finesse the intermediation of human bureaucrats in order to foster more transparent and better governance.

Still in the field of information networks, we create Centres offering awareness and introductory courses in e-business. E-business is far behind in our second group of countries compared to the first one. There is often a circular causation in a firm's decision to get involved in a network. The decision to join is determined by the size of the network, while the size of the network is, in turn, determined by all the firms' decisions to join. As long as the individual firms lack the information to coordinate their decisions, the externalities that could result from networking are lost. This delays unduly the formation of networks and the closure of the digital divide. The mission of the Centres is to provide a certain degree of systemic coordination in order to entice agents to involve themselves in e-business.

We also propose policies to augment the level of human capital held by the poor, to support domestic-oriented firms that provide the local goods adjusted to the demand pattern of the poor, and to protect the domestic market against spillovers that can lead to socially excessive expenditures when new products are introduced through the eviction of traditional ones.

We facilitate direct investments and transfers of technologies to increase productivity in the recipient countries (and reduce the cost at the end of the value chain). It is well known that investment by external investors, as well as the search for external R&D by domestic investors, engenders information asymmetries and contractual incompleteness between the two parties involved. Among other concerns, these market imperfections can result in inefficient effort provision by the external party or an adverse selection problem whereby external investors cannot distinguish between profitable and unprofitable projects. In this noisy context, a certain number of promising projects will go unfounded by the private sectors. The task of UNIDO is to support these "marginal" projects by offering a platform that, for both parties, reduces the cost of information and enhances trust. In this way, a certain number of projects that the market would not have brought to life will come into being.

Of all these instruments one is explicitly dedicated to the issue of productivity and poverty. It can be consulted in the Appendix to this book.

Appendix. Poverty-Reduction Industrial Centers (PRINCES)

A concept introduced at the inception of this Millennium to implement UNIDO's poverty-reduction solution.

Foreword by Carlos Magariños, Director General of UNIDO

The motto of UNIDO's corporate strategy is "productivity enhancement for social advance".[87] For a strategy to work, all the activities it encompasses must be congruent with the general direction imparted. Clearly, as with any other activity, this initiative, too, must be seen to make a contribution to productivity enhancement and social advance. This new concept will make strategic sense under two conditions. First, it must lead to an enhancement of productivity. Since productivity is what UNIDO does, this condition will be satisfied if decentralization achieves an increase in the global efficiency of UNIDO. Second, this enhancement must serve social advance, not merely economic growth.

Given that the decentralized UNIDO must be able to deliver more with the same resources, the shift to the field may not be allowed to entail a loss in the delivery capability. On the contrary, this capability must be strengthened. One obvious way to do this is to use the capability more continuously to its full potential. Accordingly, productivity enhancement for social advance will have to be carried to the countries by vectors capable of knitting together the whole range of UNIDO's technical assistance and global forum intelligence. For maximum impact, these vectors will have to be aimed at well-specified objectives and their trajectories will have to be guided by logical models of causality.

There are many ways to define social advance. Income, equity, and access to broader opportunities are some of the various facets that could be emphasized. But the one facet that trumps all others is poverty reduction. Once the focus is placed on the poverty-reduction facet of social advance, the motto can be re-formulated as, "productivity enhancement for poverty reduction". In the era of the UN Millennium Development Goals, there is no higher legitimacy for international action than an explicit pro-poor orientation. UNIDO does not appear to have done enough to exhibit its engagement in the cause of poverty reduction. Up to now our Organization has not boasted a specialized instrument explicitly committed to the fight against poverty and readily recognizable as such by the rest of the international community and by the developing countries. A poverty-reduction banner is needed. It will be up to our new concept to fly it.

[87] 'See UNIDO, Developing Industry: productivity enhancement for social advance, Vienna, 2003.

Introduction

This appendix indicates how industrial development can be enlisted in the fight against poverty and presents UNIDO's instrument of choice to deliver that fight.

Section 1. Industrial development in the fight against poverty

1.1. The link between productivity and poverty reduction

What link can there be between the abstract concept of productivity – a synthetic indicator constructed as the quotient of inputs and outputs – and poverty reduction? It is a link that takes us through the contribution of industry to productivity; then from productivity to job creation; and, finally, from job creation to poverty reduction. In the reverse order:

From job creation to poverty reduction

The link between job creation and poverty reduction is straightforward. The quality of life of everybody is bound to suffer in a society with exclusion and dualism. Exclusion and dualism occur when there are not enough stable jobs for everybody. A stable job, i.e., one where both parties anticipate a certain continuity of the work relationship, is not simply a source of income but is also the foundation on which to build other kinds of stable relationships – like creating a family, making friends, buying a house, developing consumption habits, and so forth. For these reasons, the creation of stable jobs for the poor is the natural way to concretely pursue poverty reduction.

From productivity to job creation

The link between productivity and the creation of jobs is strong but somewhat complex. In a static formulation, employment and productivity are in an inverse relationship: A given quantity of work to be done will require fewer and fewer jobs as productivity increases. In dynamics, though, the relationship is altogether different. Real wages divided by labour productivity is what defines the share of the wage bill in value added. Thanks to this relationship, the share of the wage bill can be reduced without affecting the income of the workers. The larger capital residual stimulates investment and, finally, jobs.

From productivity to industry

Since productivity is a key to employment growth, it is clear that productivity enhancement per se is conducive to social advance. UNIDO adopted its motto precisely because productivity enhancement is always worth working on.

However, if one wants to enhance productivity specifically in order to achieve poverty reduction, then productivity processes must be brought to where the lack of jobs is most acute. Except in city-states, the most obvious aspect of poverty in any country is regional. An abysmal poverty in some regions contrasting with wealth in others is the common lot of countries at all level of development. Just one example of regional imbalance, the South-eastern region of Mexico (Chiapas, Guerrero, Oaxaca), a country where income inequality is on the second rank in Latin America – which is itself the region with the highest degree of inequality in the world – contained 9 percent of Mexico's population, in 1994, but 19 percent of the country's poor." [88] Furthermore, regional imbalances seem to resist growth. Global income inequality is on the decrease, at least since 1980 (principally thanks to the growth of China), but within-country disparities have increased slightly.[89] Because of its important spatial dimension, the best way to fight poverty is to foster productivity right in the poorest areas of a country.

How then can productivity be brought where it is needed? Productivity, as mentioned above, is nothing more than a concept. It cannot be put into action unless incarnated in some activities involving the transformation of inputs into outputs.

In general, productivity gains come from the rationalization of the traditional sector and the expansion of the modern sector. In developing countries, the traditional sector is agriculture and the modern sector is manufacturing. Both sectors can produce productivity gains, but in the case of agriculture these gains result in the release of jobs because the growth of agricultural output is constrained by supply and demand rigidities whereas the limitless expansion typical of industry permits both productivity gains and job expansion. Hence, the force that drives productivity growth is industry[90] and the activities of choice to link productivity to job creation are the manufacturing activities. This is why, for example, in the Cameroon's Poverty Reduction Strategy Paper one can read, "The government gives top priority to the industrial sector, which it regards as the key source of poverty-reducing growth in the medium term."[91] Based on the example of developed countries – where services are the modern sector – it is

[88] See Corbacho, A., and Schwarz, G., "Mexico: Experiences with Pro-Poor Expenditure Policies", IMF Working Paper, January 2002, p.11.

[89] See Sala-i-Martin, The Disturbing "Rise of Global Inequality", NBER Working Paper, No w8904, April 2002.

[90] The robustness in time and place of Verdoorn's Law linking productivity to manufacturing growth is well established except for signs of de-linking starting in the 80s in the most advanced developed countries.

[91] See Republic of Cameroon, Poverty Reduction Strategy Paper, April 2003, p.46. A Poverty Reduction Strategy Paper is indispensable to accessing the Poverty Reduction Growth Facility, which is the IMF window to explicitly pro-poor concessional loans.

sometimes assumed that it is the service sector that offers the best potential for job creation. As far as developing countries are concerned, this is not so. The service sector cannot develop further than non-market services (government, health, education) until a solid foundation of manufacturing industries is available to nurture it. Once a sizable industrial sector comes into existence, the market services will be boosted because industry typically spends about a fourth of its income on tertiary activities, like transport, advertising, legal services, cleaning, travel, and so forth. Hence, only industrial expansion can provide massive employment to a society emerging from agriculture. The best contemporaneous example is the manufacturing sector of China, where millions of standard jobs accessible to almost anybody are mopping up large (but by no means all) numbers of workers released by agricultural modernization. It has been argued that, in the hyper-modern world of the light economy, the bedrock of industry is no longer needed for services to flourish. This argument does not take into account the "home market effect" principle, which states that the home market is the core of an economy because this is its main market. Even though there are interesting examples of export-led developments of services, like the computer-related jobs created in India, they look more like exceptions than the rule. These are highly qualified jobs that are, by definition, accessible only to a tiny minority of the work force.

From industry to poverty reduction

The concatenation "poverty-jobs-productivity-industry" does not necessarily loop to form the circle "poverty-jobs-productivity-industry-poverty". The nexus industry to poverty reduction is not guaranteed; it has to be bolstered.

First, there is a quantitative dimension that must be taken care of. Industrial growth can be more or less labour intensive. It ought to be labour intensive in places that have a comparative advantage in labour-intensive activities. When the battle against poverty is conducted within a country, this means that the areas to be industrialized are those that are not only depressed but also relatively well endowed in unskilled labour.

Second, there is a qualitative dimension. Within this dimension, it must be noted, industry can offer jobs to unskilled people but not to those who have no qualifications whatsoever to take on modern jobs. There is no point in fostering industry in places where people are still completely immersed in traditional production modes. In these places industry can only enter into the picture in the long run, after basic education has produced effects.

There is also another qualitative aspect to take into account, and it concerns the stability of the jobs created. Albeit all jobs contribute to poverty alleviation (where the roots of poverty remain untouched but the effects are temporarily alleviated) in the sense that they all create income, not all are factors of poverty reduction (where the conditions of poverty are permanently eradicated). It is not enough, for instance, to seek regional growth by using a program to train manpower and modernize infrastructure as a way of attracting foreign investment. Such a policy runs the risk of desertion by the foreign companies as soon as even better conditions are offered

elsewhere. Examples abound of footloose industries that visit briefly and leave behind them only a dissolved social fabric.

By contrast, the kinds of jobs that are sources of poverty reduction are those that ensure social insertion and progressive know-how acquisition. These jobs are typically found in lasting and progressive firms that have a vested interest in their surrounding region. Given the spatial dimension of the poverty problem, it is posited that the best way to fight poverty is to persuade firms like these to take root in the poor regions of a country.

The circle from industry to poverty is now complete. The next step is to implement the circle. This will require, in the first place, the elaboration of an industrial program.

1.2. A poverty-reduction program for industry

1.2.1. The case for a program

Industrialization is a necessary but not a sufficient condition to reduce poverty. Hence, when poverty reduction is intended, one must foster the particular kind of industrialization that is appropriate to that intent; a kind that consists of generating the right jobs in the right places, in other words, in attracting industrial firms to offer jobs in poor areas relatively well endowed with unskilled labour.

That is, of course, easier said than done. It is well known that economic space results from a balance between agglomeration and dispersion forces. The agglomeration of economic activities is a factor of growth because it provides multiple externalities and improves the productivity of individual firms. The force of agglomeration is normally found in cities because they are communication hubs, bureaucratic centres, and consumer pools. The concentration of activities in cities is self-reinforcing: New firms have a high propensity to settle in places where economic activities are already flourishing. Of course, the spiralling growth in certain places sucks out the growth chances of the rest of the country. Workers leave their homes and take their expenditures with them to the places of concentration. In these places demand grows, but elsewhere demand decreases, notwithstanding the remittance of a part of the wages earned in the cities. As local demand is depressed because there are no local wages, ever fewer firms are tempted to settle in the poor areas. In the long run, forces of dispersion will be set in motion as profit-seeking firms, deterred by rising congestion costs in incumbent agglomerations, will look for less congested places with low wages. But, as far as poverty reduction is concerned, the long run is not in the timetable of the international community.

To face the disarticulating trend described above, something more than the mere passage of time is needed. What is needed is a program of intervention to quickly foster the installation or development of firms in poor areas.

It is well known that intervention may sometimes have unpredictable outcomes and always demands above-standard governance. This, for many, is ground enough to preclude all interventions. UNIDO's view, however, is more selective. Carlos Magariños adheres to the formula "The market where possible, the state where needed."[92]

His position would already be justified by the plain fact that the market mechanisms, at their best, yield efficiency but not necessarily equity. But there is more. In developing countries the market mechanisms are not at their best and therefore often fail to deliver efficiency. Indeed, massive unemployment in the presence of huge unfilled needs is the sign of a significant waste of resources and the hallmark of inefficiency.

In the goal discussed here, poverty reduction through the generation of industrial jobs in poor areas, state intervention is certainly needed on the grounds of market failure. In the particular case of industrial agglomerations, efficiency is most probably not satisfied. The reasons to believe that the market outcome is not efficient are, on the one hand, that the very cause of agglomeration is that it allows firms to price above marginal cost and, on the other hand, that there is a failure to account for the gains and losses that the internal migration of workers generates both in the host region and in the region left behind. Left to the mere action of market forces, the situation runs the risk of becoming self-perpetuating due to the above-mentioned coordination failure, or aggregate demand externality. The firms do not offer local jobs because demand is too weak; without jobs people do not earn wages; without incomes demand is depressed. The downward spiral lasts until an outside shock breaks it. Thus, by itself, the consideration of efficiency most probably requires some intervention on the part of the state.

Anyway, in the case of the fight against poverty, considerations of efficiency give room to considerations of equity. In matters of equity, the state is the only institution that can represent the viewpoint of all citizens, including the poor. Whether and how the state will intervene depends on societal values. The values and attitudes with regard to poverty differ across societies. Some are more tolerant of, other more adverse to poverty. If a society is indulgent towards poverty, the economic outcome of agglomeration, perhaps amended on efficiency grounds by some policy measures, may turn out to be the preferred social outcome. But the goal of poverty reduction postulates a society with aversion to poverty, and, in this case, it is dispersion, no longer agglomeration, that is likely to become the preferred outcome.

To obtain dispersion, i.e. the deployment of industrial jobs in poor areas, interventions are clearly indicated. This implies that the implementation of UNIDO's poverty-reduction solution will necessarily take place in the context of a national program including not simply region-favouring policy recommendations but also the financial means to secure the implementation of the recommendations.

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[92] See Magariños, C., Redescubrir la función del Estado, ONUDI, Un espacio para la reflexión regional, Editorial, Junio/Julio 2003, No 4, Montevideo.

1.2.2. The nature of the program

It is futile to speculate on the details of the national programs that UNIDO's poverty-solution may encounter in the field. However, in very general terms, it can be stated that these programs would include:

- Support for business investments to strengthen, modernize and rationalize existing firms (even though these investments are likely to be labour-saving)
- Support for business investment in new ventures (even though the immediate prospect for new businesses is, by definition, limited in areas of depressed demand);
- Support for the incorporation of labour inputs in business activities
- Support for private and public investment in infrastructure (with discrimination in favour of investments enhancing the productivity of the supply sector and against transport investments because the latter reduce the transport costs and hence increase the competition by firms from agglomeration centres)

"Support" in the above context is a general term meant to encompass subsidies or tax alleviation to labour inputs, improvement of the institutional access to funding, and technical assistance support.

It would not be realistic to imagine that the real-world implementation of a program could go without defects and distortions,[93] but neither would UNIDO wish to join a program with more costs than benefits. It would rather join a program that takes into account the following pitfalls, indicated by years of experience of welfare states in developed and developing countries:

- The measures to be taken should preclude the introduction of rigidities in the labour markets.
- A program of intervention increases the size of government and requires funding, at a risk of inefficiency; governance should be watched closely.
- A program of intervention may fail and, in the event of a lasting lack of results, may lead to cumulative deficits. The importance of fiscal balance cannot be overstated in the management of an economy. Hence, only successful programs should be allowed to continue.

[93] In theory non-distortive lump-sum transfers could suitably redistribute welfare across individuals. In practice, the chances are that such transfers could neither be calculated nor implemented.

Section 2. UNIDO's instrument of choice for poverty-reduction

2.1. The Prince concept.

In countries with poverty-reduction programs, UNIDO will project its full developmental potential through a vector able to knit together the whole gamut of technical assistance and research capability at the service of poverty reduction through the generation of industrial jobs in depressed areas.

This vector, named Poverty-Reduction Industrial Centre (Prince), will be established directly in selected area(s) of the host countries of UNIDO's regional offices. The nucleus of this entity is to be manned by personnel to be re-deployed abroad, supported by locally contracted staff. The size and configuration of each Prince would vary with the progress of its task. The nucleus will be re-enforced in the course of operations by task forces mobilized from Headquarters and seconded to the field for the duration of the particular task at hand.

The sole goal of the Prince will be to bolster the generation of industrial jobs in the host area. Accordingly, the Princes will be dedicated to support business installation, rationalization, modernization, and expansion, as well as infrastructure investment. The support will consist in policy recommendations, technical assistance, search for institutional funding, and advocacy.

Of course, all these services have to be deployed in an optimal manner. It will be the responsibility of the Prince to put in place a business plan ordaining all its efforts to the pursuance of that particular objective. The business plan is not only a logical management tool; it is also an evaluation tool allowing comparison of the situation observed after intervention with the situation that would have obtained had there been no intervention at all. That business plan will have to be congruent with the host country's poverty-reduction program.

As everybody knows, intervention at firm level is questionable, but the interventions of the Princes would be confined to the whole group of firms, and would never reach the individual level. Arguably, the supply of collective support is a public good because the market will not produce a profit-seeking agent to perform that function. There are no markets for hiring private consulting firms because individual firms are not actual clients for collective measures, and the existence of moral hazard impedes them from becoming a collective client as long as an external agent does not coordinate their decisions.

It was said above that no intervention program should be allowed to fail completely. This holds true for the Prince. Hence, from its very inception, the Prince will have to be fitted with a tool for measuring its impact and comparing this to the cumulative costs of the management, implementation, and acquisition of assets. To evaluate its impact, two levels of observation must be available: first, the sum of microeconomic effects and, then, the positive and negative macroeconomic consequences and feedbacks. To assess quantitatively the impact at these levels, the instrument of choice would be a random experiment comparing the evolutions of

productivity and job creation in the area of intervention and in other areas. In this case, measurements will have to be made both in the target area and in the control areas from the beginning of the Prince operations, otherwise the data will not be available at the time of the evaluation.

Given the importance of documenting both what is done and the social value of what is done, every Prince will be fitted with a Productivity Unit in charge of monitoring, benchmarking and analyzing the performance of the targeted firms. The groundwork of this Productivity Unit will be to ferret out data from the firms supported by the Prince as well as from control firms in the country (for the latter, the primary source of data could, perhaps, be the National Statistical Offices) and to prepare analytical reports. These reports will provide the original insider material that will, in the future, be the stuff of which most of UNIDO's research will be made.

Significant results should not be expected in the short run since job creation requires the organization and evolution of productive activities as well as some restructuring of final demand. It is expected, however, that after four years the changes engendered through the intervention of the Prince will start showing measurable effects. The firms in the target group should have become significantly less vulnerable to risks and should have generated more jobs than firms in control groups. Furthermore, the target area should have become attractive for new firms interested in sharing the local externalities.

It may seem exceedingly ambitious to assign only four years to transform firms that are on the brink of starvation in poor areas and, indeed, to render a depressed area attractive. Yet, it is deemed possible.

The changes in question consist, partly, in attracting new firms and new infrastructure but, principally, in re-organizing and overhauling incumbent firms. The panoply of UNIDO is comprised precisely of services that, in the course of the years, have been tested and used to obtain these kinds of change. To mention only some categories of services available:

- Technology transfer. Overhauling the incumbent firms means, to a certain extent, modernizing their technology. All empirical studies show that, no matter in which country, there are wide spreads between the best and the worst practice observed at plant level. This indicates the ubiquity of technological reservoirs that can be transferred from one part of the country to another. As the transfer is to take place within the same country, the technology absorption problem is deemed much less complicated than between countries.

- Organizational support. UNIDO provides services specialized in transforming local agglomerations of firms into clusters. The key word to be used here is "coordination" – the coordination of activities among members of the future cluster. In some cases, clusters could be organized to supply the national super-market chains in products from the area. In these cases, an optimal purchasing and supply-management system encompassing all the constituent firms would be established. Another way to foster clusters is to obtain the

sharing of fixed assets (waste management systems, anti-pollution systems, energy systems, info-structures, and so on).

- Process enhancement training. Pertinent here are four UNIDO programs usually taught in the form of periodic (at least yearly) forums, workshops and seminars:
  1 Quality of production
  2 Cleanliness of production
  3 Energy efficiency
  4 Technology foresight

- Trade Barrier Breaker. A group of services to upgrade supply so that it can access international markets. These services are normally supported by market penetration services that keep a watch on the emerging markets, survey the access conditions to the targeted markets, organize collective commercial missions, develop and maintain e-commerce facilities at the cluster level, set up a virtual fair of cluster products, and review the export performance of the firms and derive corrective or incentive measures.

- Investment promotion. Here are services that could be used to seek institutional financing for infrastructure projects. In the present pro-poor stance, the Bretton Woods institutions and the regional banks are open to initiatives focused on concrete poverty-reduction solutions. This is precisely what the Princes are about.

2.2. The Prince's target group

The coveted jobs will be nested in firms. What kind of firms are likely to offer the right jobs? The ideal firm is one with strong local ties and good chances of being lasting and progressive. The latter requirement seems to preclude firms that, for one reason or another, are not deemed to have a reasonable life expectancy. The target group should not include firms that have been in the market for less than two years (these firms are less likely to survive than older firms), firms that are very small (these are much less likely to increase their personnel than are larger firms), or handicrafts (these businesses have to jump over too high a technological hurdle to have a reasonable chance of becoming progressive).

Criteria for inclusion in the target group are more difficult to establish. It is unfeasible to examine all the firms of a region, one by one, in order to detect those with the desirable characteristics. All that can be done in this respect is to define the rough profile of firms to be deemed worthy of support. Intuitively, such firms would be found in sectors satisfying the following six criteria.

1. Since a lasting job is one that provides prospects of return to the firm that deploys it, and is also one for which the firm will find labour inputs with the right costs and qualifications, it follows that the *firms that hold the best promise of achieving poverty reduction ore more likely to seek profit in the deployment of low-productivity, or unskilled, jobs.*

   This criterion may be somewhat difficult to swallow after all that has been said above about the link between productivity and job creation. Why not seek high productivity directly in order to maximize job creation? Before addressing this question, it must first be emphasized that the "low-productivity jobs" promoted in the poverty-reduction strategy may be downscale in the productivity range of modern industrial firms, but this range is situated well above the range of labour productivity encountered in poor areas deprived of modern industrial firms. Even so, it may appear, intuitively, that jobs situated upscale in the productivity range of modern industrial firms are more desirable than low-productivity jobs. But this view holds only for the long-term. In the medium-run, the remuneration of high productivity jobs would be too expensive to allow for significant job creation. In any economy, the share of the wage bill in value-added can be only as much as will entice capital to come and stay. At a given share, if the wage rate rises, the number of workers has to decrease.[94] But in poor regions the share of the wage bill can't be very high. High-tech or capital-intensive industries need a proper turf to prosper. In environments challenged in terms of qualifications, externalities or infrastructure, these kinds of industries would run a daunting risk of being asphyxiated, and this risk must be remunerated if capital is to take it. If the share of the wage bill cannot be high, then the only way to promote employment is through low wage rates. But this is not compatible with the high qualifications required for high-productivity jobs. Poor regions are regions where firms have not made previous tangible and intangible investments in building up highly qualified job positions. In that kind of environment, totally deprived of externalities, it is extremely difficult to put highly qualified labour to work and, anyway, qualified labour is simply not available. To be viable on the labour market, these jobs would have to be highly remunerated at least in real terms, i.e. in comparison with other goods and services, in particular the services of poorly qualified jobs. High-productivity jobs in the poorest areas are a developmental objective but not an actual possibility for the immediate future. Healthy low-productivity jobs today are the stepping-stone for high-productivity jobs tomorrow. If the automotive industry is now starting in China, it is because it was preceded by multiple layers of much more basic manufacturing. Of course, there is no denying that there will always be odd firms that will succeed in the high labour-productivity range. But such firms would be either too risky or too successful to be contemplated for inclusion in the scope of a poverty-reduction strategy run by UNIDO.

[94] Developed countries too are submitted to this rule. In Europe the gains of productivity are traditionally devolved to the workers in the form of high salaries. The trade off is that the high share of the wage bill in value added makes it impossible to employ fully the workers with low qualifications. By contrast, in the USA the fruit of productivity does not so wholesomely land in the hands of workers thereby allowing firms to hire less qualified jobs.

2. Since low-productivity jobs are profitable only in combination with low capital intensity, suitable *firms are more likely to be found among the labour-intensive industries, the so-called "light" industries.*

   As was said above, labour-intensity is used here in a within-country context.[95] Accordingly, we are talking of firms located in depressed areas relatively well endowed in labour and with relatively low real wages.

3. Light industries can be based on low-productivity labour combined with imported products (maquiladoras) or they can be based on low-productivity labour combined with local products from nature. The former case leads to entirely footloose industries; the latter to industries deeply rooted in the comparative advantages of their environment. *Suitable firms are more likely to transform natural products from the local environment.*

   This seems to be the route taken in Argentina and Peru, with the emerging specializations respectively, in agro-food and natural fibre textiles. It is perhaps no wonder that it is in transforming the chocolate of Ecuador, the zebu hides of Ethiopia, the alpaca wool of Peru, or the fish of Lake Victoria that UNIDO has scored its most visible poverty-reduction hits.

4. There is a set of industries in which a plant's revenue productivity depends little on the efficiency of plant-level production processes and strongly on the success of the firm in innovating and diversifying its products. There is also a set of industries in which plant-level productivity reflects process efficiency and improvements in the inputs. *Suitable firms are more likely to belong to the latter than to the former category.* In the first case, the firm will depend on R&D and on close contacts with clients to an extent that would be very difficult to sustain in poor areas. In the second case, labour productivity gains come from two sources: on the one hand, the technical progress from the innovations-of-engineers-and-managers that ends up improving economic efficiency; on the other, the fruit of investment that puts more capital in the hands of every worker and therefore improves productivity. As will be seen later, there are reasons to hope that both these sources could be tapped.

5. Even though not focused on innovation, suitable firms must be capable of progress; and progress, as far as industry goes, requires economies of scales, externalities, and

[95] Internationally, for the time being, labour-intensive specialization seems to be the privilege of South East Asian countries. In Africa specialization seems to be based on natural resources (see Wood, A., Alternative Paths to Prosperity: The Evidence from Africa and South Asia, in Magariños, C., and Sercovich, F., eds., Updating and Fleshing out the Development Agenda, Papers and Proceedings of the Venice II Meeting, UNIDO, 2002, pp.79-92). In Latin America, the indicated specialization seems to be land intensive. Of course, a land-intensive specialization can be combined either with labour-intensive techniques, like the natural fiber textiles of Peru, or with labour-saving techniques, like the Argentinean or Chilean agro-food.

flexibility. When it comes to small-scale firms, the only organizational form capable of meeting all these attributes is the celebrated cluster of firms. A cluster of firms is not simply a group of firms maintaining dense input-output relationships among themselves. In a cluster, the members share the ownership and cost of some physical or virtual assets. Every firm looks after its own interests but, through the common asset, participates in a system that shares information and services (marketing abroad, support of innovations, waste disposal and management of the ecology, formation of manpower, fund mobilization, etc.). This organizational form provides the group with externalities, scale and scope economies, output diversification and flexibility that would be missing to the individual participants.

Clusters need not be agglomerations (spatial concentration of firms) but, most of the time, clusters do happen to be agglomerations (inversely, only a small portion of agglomerations are clusters). Here, of course, the interest is focused on locally concentrated clusters. *Suitable firms are more likely to belong to a cluster.*

6. Job creation can only take place when the resulting production is sold. The poverty of the area of intervention is, of course, antagonistic to sales. Accordingly, poverty reduction implies connection to distant markets through exports. To export is a matter of competitiveness. Competitiveness, obviously, comes from price, from quality, and from product specification. But it also comes from an environment fostering business linkages. *Suitable firms ore more likely to be firms with an extra-edge when it comes to opening distant markets*

2.3. The Prince's functions

Finding an anchorage

Initially, the Prince will be in an embryonic state comprised only of the field representative of UNIDO, supported, when the opportunity arises, by a mission from headquarters. The only conceivable mode of existence for a Prince is a complete engagement in the national efforts. Hence, the first task of the embryonic Princes will be to identify the national sources of dynamism (agents, institutions, and resources) that can be rallied. Speculatively, examples of national programs that could harbour a Prince are the Chinese program to reverse the migration of labour from the countryside to the cities, or the South African program for the empowerment of the black population. It is only in interaction with ongoing domestic programs that it will be possible to specify in detail the particular functions that the Princes will exert in their respective host countries.

During the search for an anchorage, the function of the embryonic Prince will simply be to advocate poverty reduction through the generation of industrial jobs in poor areas and to advertise the contributions that the Prince has to offer towards this objective. An initial

Industry-Poverty Forum in the host country may be useful to socialize the topic and obtain the necessary introductions to governmental counterparts and economic agents.

The anchorage will be found once an institutional national counterpart has been determined and once UNIDO's initiative is clearly connected to a national program of poverty reduction.

Defining the target group

It is a distinctive feature of the Prince that its scope of action will be focused exclusively on a target group of firms located in a depressed area. Accordingly, once a decision has been reached to set up a Prince, headquarter personnel supported by the field representative of UNIDO and by national consultants will initiate the task of identifying a depressed area containing a pool of *firms with the potential to become progressive.*

There can be no uniform methodology for this. In some countries, not the majority alas, very useful statistical evidence will be at hand. Plant-level data collected by industrial censuses may deliver practically all the information needed to profile the six categories of interest. But all-purpose statistical data can only be subsidiary to inquiries specifically geared to the topic of interest. The Prince will have to elicit all the knowledge available in the Government, the civil society, academia, and so forth, to select a feasible and socially desirable target. Based on this intelligence, the selection itself will have to be made with a cocktail of rationality and pragmatism that, hopefully, will provide a consensual base for the action envisaged.

Taking root in the targeted area

The Prince will take root in the selected area in the form of a permanent office manned by a professional staff detached from headquarters, a locally recruited professional staff, and two locally recruited administrative support staff. The headquarters professional will remain in place for two years to train the local professional; after the first two years, the Prince will only have three permanent staff.

To promote its presence throughout the targeted area, the operational Prince, in cooperation with the field representative of UNIDO and specialist national consultants, will have to start with encouraging positive perspectives on the area considered. It is to be expected that in backward areas the mood is gloomy. Given that agent expectations largely shape the real conditions, a depressive mood may well work as a self-fulfilling prophecy. It is therefore important to deploy perspectives capable of redressing the confidence local actors have in their potential. To this end three approaches are contemplated.

First, all that is possible must be done to inform local actors of the real extent of the help they *can marshal. In practically every country there are manifold dispositions – fiscal, financial,* legal, and administrative – concerning the labour, social, tax, environmental, safety, credit, and other aspects of the economic life – that can be of real help to the development of backward

areas. In addition to dispositions, there is also a diversified range of resources, both human and financial, available from international, national or local sources. Too often, those who most need this potential help are either unaware of it, or at least not fully aware, or do not use it effectively because it involves too much red tape.

What Princes are intended to do in this respect is to put the information in a usable form and place it in the hands of the users. Admittedly, almost all countries claim to have already set up single-window facilities offering all there is to be known at the click of a mouse. But single-windows are passive responders only usable by those who are aware of the right sequence of questions. People in general, and those in backward areas are certainly no exception, know their needs but not how to formulate them to suit the protocols of single-window facilities. A solution here is an active intermediary with a deep understanding of the local problems and the ability to connect these problems to available assistance.

Second, there must be an attempt to make a case for incentives specifically designed for the targeted set of firms. These incentives (support to RM applied to local activities, alleviation of social charges on local low-productivity labour, collective training in the qualifications locally needed, installation of local infrastructure, etc.), completed by a transparent and stable legislative environment, will define a frame – perhaps heralded as a "Poverty-reduction Regime" – in which local firms will be able to invest and transact safely over the medium and long run. Here, the role of the Prince will be to suggest an apt assistance package and to promote its application.

Third, if there is a specific regime, it must respect the WTO rules and it must be conditioned upon the fulfilment of credible targets. This means that the regime will have to be audited from its inception and throughout its lifetime to provide evidence of effectiveness and fair play. Thanks to its international assistance status, the Prince would appear to be a suitable honest broker to ensure impartial audits.

Designing an optimal program for UNIDO's interventions

A Prince is brought into operation with the goal of bolstering job creation in a pool of potentially progressive firms located in a depressed area. In order to achieve this goal, UNIDO will place the totality of its services at the disposal of the Prince. Of course, not all the services need be engaged, only those required in the particular circumstances of the area.

Once the target group is identified and the broad lines of a potential development drawn to the members of the group, the Prince will start its operational life by calling a programming mission. The technical experts from headquarters will interact with the targeted firms to design elements of an integrated program of technical assistance. To be incorporated in the program, any component must make the demonstration (if x, then y), or, at least, establish the plausible assumption, that it will be causal in generating the expected outcome, and must dispel any alternative scenarios suggesting that the causality would not work. The logical model specifying

the sequence of causal actions proposed by the experts will have to be validated by the Prince and a representation of the target group.

Installing a monitoring system

It has been stated that the existence of the Prince should be conditional upon success (an excess of social benefits over direct and indirect costs). To establish whether this is the case, a monitoring system capable of comparing a particular impact on the existing situation to an expected outcome must be mounted from the very beginning. To establish that capacity, a set of indicators must be designed and the data must be collected from the inception of the operational existence of the Prince, both in target and in control groups (This will not be an instantaneous operation since the indicators selected must be relevant to the intended measurements; should be an accurate surrogate of the reality to be measured; should be practical; and should be as immune as possible from measurement errors). This function will be exerted jointly by the staff attached to the Prince and by missions from headquarters.

Coordinating and monitoring implementation

During this phase, the functions of the Prince will be the coordination and monitoring of the implementation of UNIDO's interventions.

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